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This Note provides a description and assessment of the Air Force's current enlisted force planning and programming system, and concepts and recommendations for the development of an improved system. The new system has been designed to overcome the deficiences and enhance the capabilities of the present system. Because many enlisted force management activities have good support systems, the recommended system will be directed toward grade restructuring, personnel planning, and personnel programming.

deficiencies

A RAND NOTE

CONCEPTUAL DESIGN OF AN ENLISTED FORCE
MANAGEMENT SYSTEM FOR THE AIR FORCE

Grace M. Carter, Jan M. Chaiken,
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August 1983

N-2005-AF

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35th Year

Rand
SANTA MONICA, CA. 90406

PREFACE

This Note provides a description and assessment of the Air Force's current enlisted force planning and programming system, and concepts and recommendations for the development of an improved system. It is the first publication from an effort begun in July 1981 at the request of the Directorate of Personnel Plans, Office of the Deputy Chief of Staff for Manpower and Personnel (DCS/MP), Headquarters, United States Air Force. At that time Rand was asked to perform a comprehensive review and analysis of the Air Force system for managing the enlisted force, to compare it with the systems used by the other armed services, and to make recommendations for improving the Air Force system.

In March 1982, having completed their review and analysis, the Rand project team recommended that the Air Force develop a new, integrated, computer-based Enlisted Force Management System (EFMS). Subsequently, the scope and functions of the EFMS were jointly determined by Rand and the Air Force. Then a conceptual design was prepared for the proposed system. This Note documents how the EFMS could operate and describes a suggested structure. The models it should contain and how these models would work are described in some detail (including inputs, outputs, and, in some cases, mathematical equations). The final section outlines a procedure that Rand and the Air Force could use in jointly implementing the system.

The final form of the EFMS and the way it gets implemented are unlikely to be exact reflections of the proposals in this document. Research will suggest changes, as will the dynamic environment in which the DCS/MP operates. Final authority on the form of the EFMS and how it gets implemented resides with the DCS/MP, Headquarters, United States Air Force.

The Note should be of interest to members of the manpower and personnel communities in all three military services--particularly their planners and programmers. Much of it will also be of interest to staff members in other government agencies and to those with an interest in the use of computers to support decisionmaking in the public sector.

SUMMARY

This Note serves two purposes. First, it provides an overview of enlisted force management in the U.S. armed services, including a description of the Air Force's current system for enlisted force planning and programming. Second, it provides concepts and recommendations for the development of a new Enlisted Force Management System (EFMS) for the Air Force.

The Air Force's current system (TOPCAP) was adopted in 1971. At that time it was the most advanced and sophisticated system for managing the enlisted force of all the services. Although TOPCAP has served the Air Force well, the environment in which it has had to operate has changed considerably. TOPCAP's models have not been revised to keep pace with these changes.

The new EFMS has been designed to overcome the deficiencies and enhance the capabilities of the present system. Because many enlisted force management activities have good support systems, the EFMS will be directed toward:

- Grade restructuring
- Personnel planning
- Personnel programming
- Support for PPBS cycle
- Other reporting.

Our overriding objectives in designing the system were to:

- Improve the management of the enlisted force.
- Coordinate, integrate, and unify the enlisted force planning and programming system.
- Place the user in control.
- Make the system flexible, adaptable, and easy to maintain.

For purposes of describing the system and explaining its functions, we divided the EFMS into four major sets of computer programs (modules).[1] Figure S.1 shows the four sets of modules, their interrelationships, and their most important inputs and outputs. The four major sets of modules are:

- Grade Profile Generator (GPG)
- Grade Restructuring Modules (GRM)
- Modules for Programmers
- Oversight and Short-Term Programming Modules.

The Grade Profile Generator includes a module that will determine a series of annual grade plans, rather than the single steady-state force structure generated under TOPCAP. Its primary objective when choosing among grade plans is to maintain the stability of the enlisted force management parameters (e.g., select rates, phase points, and promotion zones). The GPG will allow the user to vary inputs, such as promotion and separation rules, planned prior service (PS) accessions, and future military compensation, to examine the effects of various policies.

The Grade Restructuring Modules are designed to mediate the inherently conflicting demands of mission requirements and personnel constraints. The personnel constraints are used to adjust the distribution of grades within manpower authorizations to produce targets for MPP's programming activities.

The last two sets of computer programs constitute what the Air Force has labeled the Enlisted Programming System (ENPRO). The Modules for Programmers are concerned with supporting programming decisions, primarily for a one or two year span, but in some cases extending to the last year covered by the Program Objective Memorandum (POM). The Oversight and Short-Term Programming modules are concerned almost exclusively with the remainder of the then current fiscal year.

[1] We generally refer to the computer programs as <u>modules</u> and their mathematical specifications as <u>models</u>.

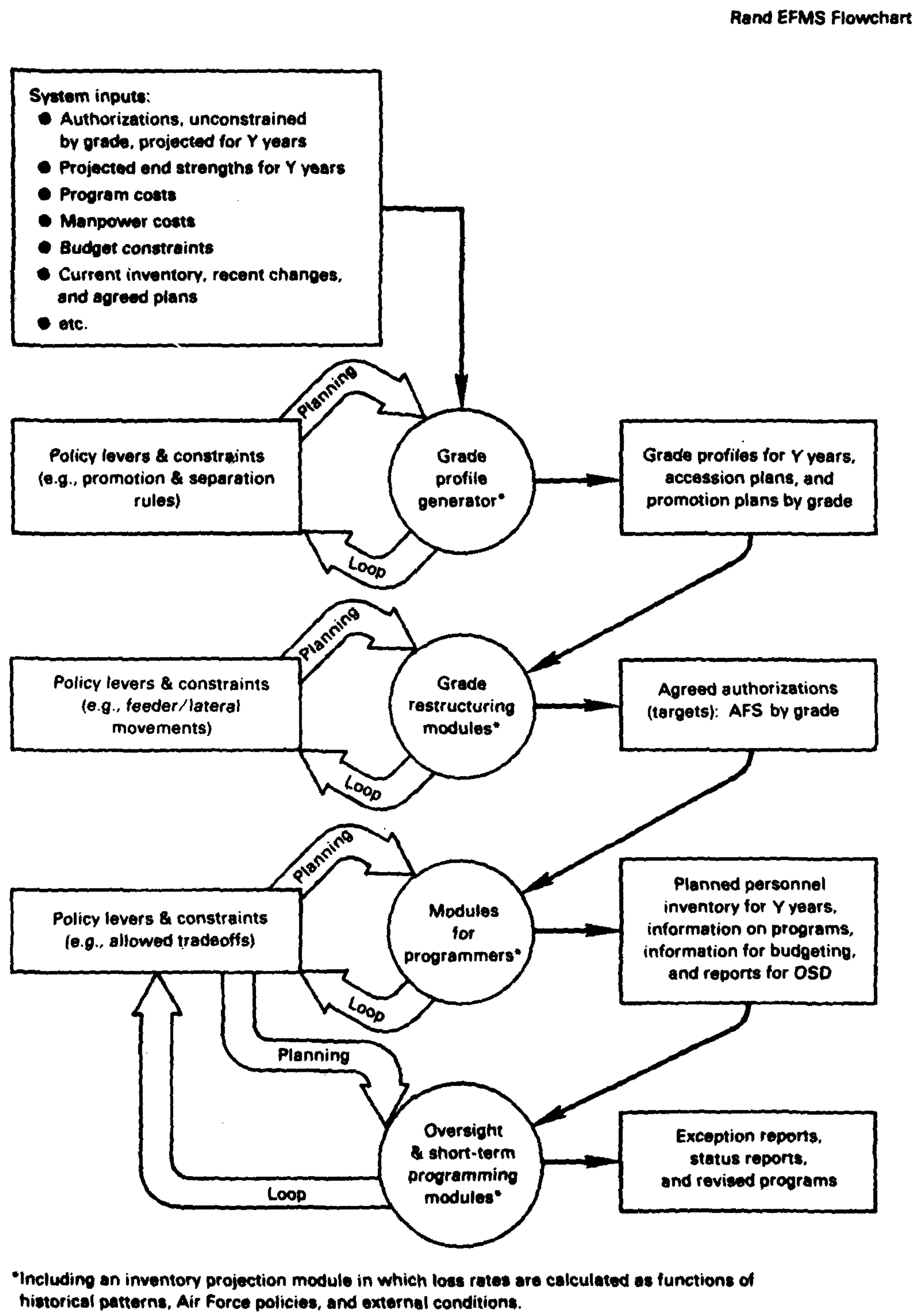

Fig. S.1 — Summary flowchart of the EFMS

These two sets of modules help personnel programmers meet the grade plans and manpower targets. If these goals are to be met over the course of several fiscal years, many programming options are available (bonuses, training programs, etc.). The Modules for Programmers will help the personnel programmer consider tradeoffs among the various options to choose an efficient way to meet the targets.

The Oversight and Short-Term Programming Modules track the progress being made toward the established targets, warn of projected deviations, and help in choosing programs to correct the projected deviations. Their major emphasis is on achieving the personnel objectives for the current fiscal year, such as meeting the end strength requirement.

Each of the four sets of functional modules contains at least one inventory projection module (IPM), which is driven by a loss module tailored to its specific needs and functions. In TOPCAP, loss rate projections are based solely on changes in the enlisted force during the preceding year. The loss modules in the EFMS will produce loss estimates that depend on assumptions regarding external economic conditions (e.g., unemployment rates) and Air Force policies (e.g., changes in bonus levels).

All of the EFMS modules will be able to be used in a "gaming" mode, which will facilitate examining the effects of varying assumptions about policies, external economic conditions, and the future characteristics of the force.

Our concept involves the use of a joint project team and staged development and implementation. The proposed project team includes Rand and Air Force analysts directed by a steering committee composed of representatives from Rand and all of the affected Air Force directorates. Responsibility for specific project tasks would be assigned to Rand or the Air Force based on comparative advantage. In staged implementation, some modules are developed in parallel with others and some are developed sequentially, in priority order. Use of a module can begin whenever it has reached the point that a user feels comfortable trying it.

ACKNOWLEDGMENTS

Many members of the Air Force's manpower and personnel community read early drafts of this Note, suggested changes to the text, and helped resolve issues raised in those drafts. Many of them also supplied information on the Air Force's current enlisted force management tools and their desires for improved tools. The following individuals in particular provided large amounts of help and support over the past two years:[1]

Directorate of Personnel Planning (AF/MPX): Col. Richard Elder, Col. Lee Forbes, Lt. Col. Michael Gaffney (the original action officer for the project), Major Daniel Leighton (the second action officer for the project), Lt. Col. William Lucas, Captain Jan D. Eakle-Cardinal

Directorate of Personnel Programs (AF/MPP): Col. Joseph Higgins, Col. Robert Walker (current action officer for the project), Lt. Col. Linda Sindt, Lt. Col. Jack Leonhardt, Major Al Robbert, Major Michael Hoffman, Major Robert Luschenat, Captain Joseph Adams, Ms. Jean Breeden, Ms. Arlene Gribben, Mr. Pat Thomson

Directorate of Manpower and Organization (AF/MPM): Col. Thomas Shinn, Lt. Col. Donald Vriezelaar, Captain Larry Ellis, Captain Roy Smoker

Air Force Manpower and Personnel Center (AFMPC): Col. Francis Le Clercq, Lt. Col. J. P. Amor, Major Robert Barnhardt, Major Rory Quesinberry, Major Charles Looney, 1 Lt. David Morrow

Air Force Management Engineering Agency (AFMEA): Major Mick Stenftenagel

Richard Kaplan of Rand's System Sciences Department read an earlier draft and suggested improvements.

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[1] The affiliation and rank shown for each individual refers to the period of direct association with the project.

ACRONYMS

AFHRL	Air Force Human Resources Laboratory
AFMEA	Air Force Management Engineering Agency
AFPAL	Airman Force Program and Longevity Model
AFQT	Armed Forces Qualification Test
AFS	Air Force Specialty
AFSC	Air Force Specialty Code
AIPS	Airman Inventory Projection System
ALPS	Airman Loss Probability System
ASKIF	Airman Skill Force Model
ATC	Air Training Command
BES	Budget Estimate Submission
CFO	Career Force Objective
CJR	Career Job Reservation
CPG	Career Progression Group
CONUS	Continental United States
DoD	Department of Defense
DOS	Date of Separation
DMDC	Defense Manpower Data Center
EAGL	Enriched Airman Gain/Loss File
EFMS	Enlisted Force Management System
ENPRO	Enlisted Programming System
ESO	Equal Selection Opportunity
ETS	Expiration of Term of Service
FY	Fiscal Year
FYDP	Five Year Defense Program
GPG	Grade Profile Generator
GRM	Grade Restructuring Modules
HYT	High Year of Tenure
IPM	Inventory Projection Model
JCS	Joint Chiefs of Staff
MAJCOM	Major Command
MPC	Manpower and Personnel Center

MPM	Directorate of Manpower and Organization
MPP	Directorate of Personnel Programs
MPX	Directorate of Personnel Plans
NCO	Non-Commissioned Officer
NPS	Nonprior Service
OBFOR	Objective Force Model
OMB	Office of Management and Budget
OSD	Office of the Secretary of Defense
PACE	Processing and Classification of Enlistees
PETS	Prior to Expiration of Term of Service
PMS	Pipeline Management System
POM	Program Objective Memorandum
PROMIS	Procurement Management Information System
PPBS	Planning, Programming, and Budgeting System
PS	Prior Service
SPM	Skill Projection Model
SRB	Selective Reenlistment Bonus
TAFMS	Total Active Federal Military Service
TEDS	Transient Entitlement Distribution System
TEMSD	Total Enlisted Military Service Date
TFMS	Total Federal Military Service
TIG	Time in Grade
TOPCAP	Total Objective Plan for Career Airman Personnel
TPR	Trained Personnel Requirements
UAR	Uniform Airman Record
WAPS	Weighted Airman Promotion System
YOS	Years of Service

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1. OVERVIEW OF ENLISTED FORCE MANAGEMENT

Effective management of the enlisted force is of increasing importance to the Air Force as it tries to carry out its mission in the face of higher costs and constrained budgets. The enlisted component of approximately 500,000 airmen constitutes over 80 percent of the Air Force's active-duty manpower and absorbs over 20 percent of its total budget. Planning for and programming of these resources to provide enough of the right kinds of people in the right grades and occupations in the right places at the right times to carry out the Air Force's missions is a monumental task. This task is the responsibility of the Office, Deputy Chief of Staff for Manpower and Personnel, Headquarters, United States Air Force.

Management of the enlisted force involves making decisions about force structure, promotion policies, and the procurement, assignment, training, compensation, separation, and retirement of personnel. Currently these decisions are made by the Air Staff using tools that have both conceptual and operational shortcomings.

Rand has been asked to take a fresh look at the Air Force's current approach to enlisted force management and to provide a conceptual and mathematical design for a new Enlisted Force Management System (EFMS) that will overcome the deficiencies and enhance the capabilities of the present system. Our approach to this task has involved the following steps:

- Specifying all activities related to management of the enlisted force
- Reviewing the methods used by the various armed services to accomplish those activities
- Identifying the scope of activities that would be supported by the EFMS
- Developing the conceptual design for an EFMS that would support those activities.

This section discusses the activities related to management of the enlisted force and identifies the subset of these activities that the EFMS will be designed to support. For convenience, we sometimes use Air Force terminology when describing other services' personnel systems.

1.1. ACTIVITIES RELATED TO ENLISTED FORCE MANAGEMENT

Enlisted force management embraces all activities that relate to the supply of and demand for enlisted personnel. For simplicity, the activities can be viewed as beginning with the determination of the manpower ("spaces") needed to accomplish the service's missions and ending with the assignment of personnel to each of the positions ("matching faces to spaces"). The activities include:

- Requirements determination
- Authorization management
- Personnel planning
- Personnel programming
- Personnel requisition and assignment
- Support for PPBS cycle
- Other reporting
- Total force planning.

As part of its Enlisted Force Management Project, Rand reviewed the way each of the four armed services carries out these activities and presented the results to the Air Staff in a briefing in March 1982. We summarize the major findings below.

1.1.1. Requirements Determination

The first step in specifying a desired force structure is to determine the levels and types of manpower required to carry out mission objectives for several years into the future. The manpower requirements are used to analyze alternatives during development of the Five Year Defense Programs (FYDP) and the budget. Manpower requirements depend not only on the mission, but also on the weapon systems that will be available to carry out the mission. By our definition, manpower requirements are unconstrained by either budget or the personnel inventory.

In most cases, the determination of manpower requirements begins with a detailed study of the work performed in work centers. Air Force Management Engineering Teams analyze work using work sampling, operational audits (essentially surveys), or relationships between input and output derived from simulation or queuing theory. They generate manpower standards that relate the work load to the amount of manpower required to do the work. Then the manpower requirements for groups or parts of work centers are related to the program elements of the FYDP (e.g., Air Force fighter squadrons).

In all the armed services, determination of manpower standards and analysis of missions are formally outside the personnel management system. However, the Navy's system (which is called ADSTAP) includes models for projecting requirements into the future and for performing sensitivity analyses of projected requirements as a function of weapon system procurement decisions. The other services have at most only data links between requirements determination and their personnel management systems. Such links allow an enlisted force management system to receive projected requirements for comparison with projected inventory and provide data that could be useful to those responsible for requirements determination.

1.1.2. Authorization Management

Authorizations, which result from applying constraints derived from funding decisions to the unconstrained manpower requirements, specify the desired allocation of manpower at the level of command, base, unit, occupational specialty, skill level, and grade. They are the targets for the personnel planning, programming, and assignment systems.

The extent to which the authorization setting process takes into account personnel availability varies among the armed services. The Air Force does not routinely consider the inventory. Therefore authorizations in some specialties have had grade structures that could never be realized because of existing personnel constraints. The Air Force Directorate of Manpower and Organization recently undertook a "grade restructuring" effort that developed a new distribution of grades for each such specialty. Major Commands are to use them in setting grades on their authorizations. This effort was to decrease the amount of cross training required to fill the authorizations and to increase the experience and skills of the resulting inventory.

The Navy routinely considers personnel inventory during the authorization process. After the manpower authorizations have been determined, the Navy determines "personnel authorizations," which describe the spaces that the Navy expects to be able to fill given the current inventory and personnel plans and policies. This system has two advantages: (1) It gives the Major Commands additional information about the personnel they will actually get, which allows them to improve their planning for personnel utilization; and (2) it provides a smooth planning target for the assignment system and clearly assigns responsibility within the personnel system. Personnel planners and programmers aim to meet manpower authorizations; the assignment system makes assignments that best match personnel authorizations.

An important aspect of authorization management is the delay between the time funding decisions are made (or changed) and when detailed authorizations are available. In the Air Force, the Major Commands determine the detailed authorizations, and two to four months normally elapse between funding decisions and the availability of data on authorizations. In the meantime, personnel plans and programs are based on projections of the authorizations. The Navy avoids these delays by using a centralized authorization management system. A computer uses allocation rules supplied by the commands to determine authorizations. By accessing the centralized computer files, the command officers can view the result and selectively override the computer's allocations.

1.1.3. Personnel Planning

For purposes of cross-service comparison, we define personnel planning as the set of activities that determine the policies under which the enlisted force will be recruited, trained, promoted, and separated. Our distinction between personnel planning and personnel programming relates primarily to the level of detail of policy specification rather than to the organizational arrangement of any one service. In particular, it may not perfectly match the activities carried out by the Air Force Directorate of Personnel Plans (MPX). In our definition, planning is responsible for policy guidance (usually at the total force level), and programming is responsible for the translation of the guidance into detailed policy specifications for each occupational field and grade. Usually planning is concerned with a longer time frame than programming. Personnel planning is included in the EFMS of all the U.S. armed services.

One of the major tasks of personnel planning is to choose a target force structure, including its composition by grade, year of service, and (sometimes) occupational specialty. Personnel programmers then use this target force to choose policy parameters.[1]

The choice of a target force requires compromising between meeting authorizations (which are an expression of funded mission needs) and having personnel policies that are conducive to high morale and retention. Ideally, the force structure should provide adequate promotion opportunity and should be consistent with equitable separation policies. In addition, enlisted personnel should be able to anticipate what their career will be like if they remain in the service, so rapid changes in personnel policies are undesirable. The time stream of manpower authorizations and "free flow" patterns of reenlistments and separations do not typically meet these personnel needs (for example, without appropriate management policies there could be grade stagnation in some specialties and rapid advancement in others). Each service resolves the inherent tension between manpower requirements and desirable personnel policies differently in designing their target force.

Currently all services develop a steady-state force called an "objective force" that represents what they consider an acceptable compromise between mission requirements and career progression requirements. The objective force is a statement of the number of personnel in each year of service, grade, and occupational category that the services would like to have. The services also develop a transition plan that shows how they plan to move the inventory toward the objective force in each of several years. A statement of the long-range target

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[1] The target force is often called the objective force.

force and of plans to move toward that target is required by DoD Instruction 1300.14.

1.1.4. Personnel Programming

We define personnel programming as the set of activities that determine the quantity of and schedule for: (1) accessions, (2) initial training, (3) reclassification (of occupational specialty), (4) retraining, (5) bonuses, (6) promotions, (7) reenlistments, and (8) separations.[2] These need to be determined for each occupational specialty by grade and year of service.[3] All the services include the personnel programming functions in their enlisted force management system, usually as the most important component.

There is some overlap between planning and programming in the realm of decisions regarding accessions, promotions, reenlistments, and separations. Part of our distinction between planning and programming lies in the responsibility of programmers for occupational specialty detail. The rest lies in the time frame and in the specificity of particular numbers.

A detailed inventory projection model is at the center of the personnel programming system of each service. The gap between the total number of enlisted personnel in the projected inventory and in either the authorizations or target force usually defines accession goals. At the occupation-specific level, a comparison of projected reenlistments with targets shows the need to change bonus levels or retrain part of the force.

The inventory models depend on predictions of continuation and loss rates, which are subject to considerable uncertainty. In almost all current systems the rates are based solely on historical rates modified by judgment but not on a systematic analysis of the effect of known changes in the environment (such as pay raises). As inventory is monitored during the year, the original projections may turn out to be

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[2] The Air Force defines personnel programming more broadly as the projection and management of enlisted force structure and costs in accordance with law, Congressional guidance, and policies of the Air Force, OSD, and the President.

[3] Except for initial training.

very wrong, in which case large changes in programs (particularly accessions) must be made during the operating year. Because the programmer's options are limited by the short time horizon, the final program decisions may be inefficient compared with the decisions that would have been made if accurate loss predictions had been available earlier.

Many of the policies used by personnel programmers have similar purposes and can be considered as tradeoffs (although the services rarely perform such tradeoff analyses). For example, one could increase the number of trained personnel that will be available a year from now in a particular specialty by increasing the bonus level, by training or retraining some enlisted members, or by obtaining prior service (PS) accessions. Because these programs have different costs, there may be an opportunity for reducing the cost of meeting inventory targets.

1.1.5. Personnel Requisition and Assignment

Personnel requisitions and assignments refer to the management tasks that deal with individual enlisted members rather than with aggregates. The activities covered include recruitment, reenlistment, and assignment to units, including overseas rotation.

The Air Force has many automated aids for making assignments. For example, PROMIS manages recruitment; the career job reservation file controls reenlistments at the career entry point; and MPC chooses airmen for overseas assignment using priority rules that involve many individual characteristics.

In almost all the services, personnel requisition and assignment functions are handled outside their enlisted force management system. The major exception is the Marines' system, which contains a module that nominates individual Marines to be moved from occupations in oversupply to those that are currently under strength. The Navy's system (ADSTAP) is tied directly to its Enlisted Personnel Requisition System.

1.1.6. Support for PPBS Cycle

The services and DoD use the Planning, Programming, and Budgeting System (PPBS) for resource planning and for justification of plans and budgets to OMB and Congress. Analysis during the PPBS cycle is done in terms of "program elements," which are primarily weapon systems. Reviews at each policy level (service, JCS, OSD, OMB, and Congress) result in updates to the FYDP and to the planned budget.

The PPBS process is closely related to many of the activities we have already discussed. Manpower requirements determination depends on the threat analyses and weapon system choices within the PPBS. Authorizations, which provide constraints on personnel planning and programming, are a function of end strength and budget decisions produced by the PPB system. Thus most manpower and personnel activities occur within the context defined by PPBS.

In addition to accepting and participating in PPBS decisions, the manpower and personnel communities provide data for consideration by additional decisionmakers. These data reports are typically output from models that have additional purposes. For example, the Marines' Inventory Projection Model provides 14 reports for the PPBS process. The Army's ELIM-COMPLIP system develops three manpower alternatives for each plan developed during the PPBS cycle.

1.1.7. Other Reporting

The enlisted force management systems of each of the services also provide data for several planning, analysis, and oversight activities occurring within that service or within DoD. For example, DoD requires a report on force targets and a report justifying the assignment of Selective Reenlistment Bonuses to skills.

1.1.8. Total Force Planning

Most of the services manage their reserve and National Guard forces using information systems that are separate from those used for managing the active force. However, many of the planning activities are similar. For example, steady-state objective forces for each reserve component are usually produced with models similar to those used by the active force. There are, of course, many differences in the context in which the reserves operate. For example, the reserves must find and assign their personnel within fixed geographic areas, and the active forces can assign personnel wherever they are needed.

Based on the documents we have reviewed, the Army's new enlisted force management system (FORECAST) shows the greatest integration of planning for the reserves with planning for the active forces. The Air Force has an Advanced Personnel Data System that includes both active and reserve personnel data. This data base could be exploited more fully to examine flows among the force components. For example, some portion of the active force losses represents reserve force gains. Models could be built to examine the effect on the total force of changing such programs as PALACE CHASE, which allows airmen to substitute some time in the reserves for part of their obligated active military service. The Air Force also has a requirements file that includes wartime requirements for the reserve forces. Thus, the basic elements are already in place for examination of personnel issues from a total force perspective.

1.2. ACTIVITIES TO BE INCLUDED IN THE AIR FORCE'S EFMS

Although it is technically feasible to develop an integrated system that would support all of the activities described above, it is not necessarily worthwhile, and no other service has yet done so. (An indication of the technical feasibility of developing a system that would include all the activities is that each of them is within the core enlisted force management system of at least one of the services.) Among the many reasons for not including all the activities within the scope of the Air Force's new EFMS are that some of the activities are already well supported by existing systems (e.g., personnel requisition and assignment) and the well known problems of developing and implementing large, multi-function, multi-user distributed data processing systems.

Discussions within the Air Staff and between Rand and the Air Staff have resulted in a decision to limit the scope of the core EFMS to the following activities:

- Grade restructuring (part of authorization management)
- Personnel planning
- Personnel programming
- Interface with PPBS
- Other reporting

To assure that enlisted force management activities are carried out in an integrated and consistent manner, the EFMS will include manual and computer interfaces with activities outside of its core. For example, manpower authorizations will be one of the system's inputs, trained personnel requirements will be supplied to the Pipeline Management System, and the Manpower and Personnel Center will supply the system with information on the current inventory.

2. CURRENT AIR FORCE SYSTEM FOR ENLISTED FORCE MANAGEMENT

2.1. GOALS OF ENLISTED FORCE MANAGEMENT

The Air Force was the first of the services to develop a comprehensive computerized system for supporting its enlisted force planning and programming activities. The system, called TOPCAP (for Total Objective Plan for Career Airman Personnel), was approved by OSD in May 1971. It was developed to meet both the Air Force's desire to improve its airman promotion program and OSD's request that the services develop new grade and career force determination and management methods.

In the late 1960s the Air Force became aware of several major problems with the structure of its enlisted force. There were relatively few airmen in the younger career force year groups and large numbers in the older groups, because of low retention rates in the 1960s following the large influx of career airmen during the Korean war. Promotion rates had varied widely over time because of changes in grade authorizations. Many specialties suffered from grade stagnation because there was a policy of promoting only to fill specific occupation and grade authorizations. This caused dissatisfaction among enlisted personnel and resulted in Congressional pressure for changes in promotion policies.[1]

In early 1967 the Air Force began a long-term study of force structure. In December 1968 DoD directed each of the services to begin similar studies. TOPCAP satisfied OSD requirements by providing an aggregate "objective" (long-range target) force, a planned career progression structure, and a management system to attain both.

The focus of TOPCAP is the career force (defined by OSD to be enlisted members with more than four years of service). The size of the career force depends on authorizations for high-skill personnel.[2] It is

[1] In 1968, a subcommittee of the House Armed Services Committee directed OSD to change its method of determining and approving the services' grade structures.

[2] The original idea behind TOPCAP was that manpower authorizations would be determined based on skill level and that personnel policy would determine grades of the people performing the jobs. This concept was never fully implemented. Currently there is a direct relationship between grade and skill level.

calculated to be the number of authorized positions for persons with skill levels 7 or 9 (grades E-6 and higher) plus the number of journeymen (grades E-4 or E-5) required to sustain the high-skill force in steady state.

TOPCAP established a visible career progression system. Until 1981 the system provided for equal selection opportunity (ESO) in all specialties. That is, the probability of being promoted out of a given grade would be identical in all specialties and independent of grade authorizations in individual specialties. Promotion zones were established for each grade, and promotion rates were calculated and published. A high year of tenure (HYT) policy (specifying the last year of TAFMS an airman is permitted to remain on active duty in a grade) was established for grades E-5 and higher.[3] In October 1981, ESO was temporarily modified (for at least three years) to allow slightly faster promotion rates in some critical skills.

TOPCAP includes two mechanisms for controlling the occupation structure: establishment of career entry quotas by Air Force Specialty Code (AFSC), and centralized retraining. In the early TOPCAP years, retraining was voluntary for all personnel beyond the first enlistment point. However, ESO is incompatible with authorizations based on requirements, because authorizations and continuation rates vary by specialty. As overages and shortages in higher skill personnel have developed over time, more aggressive retraining programs have been implemented.

2.2. MODELS IN CURRENT ENLISTED FORCE MANAGEMENT SYSTEM

To translate the TOPCAP philosophy into practice, the Air Force developed a number of computerized management models. A few of these models have fallen into disuse, most have been rewritten or revised over the years, and some are currently being used in ways that were not originally intended. The following is a very brief summary of the functions that these models were designed to perform.[4] It does not

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[3] Similar policies restrict reenlistment of persons in lower grades. For example, an individual must be promoted to grade E-5 by his tenth year of service or he will not be allowed to reenlist.

[4] More complete descriptions of the models are given in USAF Personnel Plan, Volume III, Annex F, September 1978.

necessarily reflect how the system operates in practice. Some problems with the way the system currently operates are given in Sec. 2.3. The order in which the models are described parallels the order in which the enlisted force management activities were described in Sec. 1.

Manpower requirements are generated by procedures external to TOPCAP. The Air Force Management Engineering Agency (AFMEA) develops engineered standards, statistical standards, and guides for estimating the manpower requirements for performing various tasks. The Major Commands then apply them using mission workloads to determine unconstrained manpower requirements by program element, which are major inputs into the Planning, Programming, and Budgeting (PPB) process.

During the PPB process these requirements are constrained to fit within fiscal and end-strength limits placed on the Air Force by Congress, OSD, and OMB. Among the outputs from this process are the levels of manpower authorized by command, program element, and labor type (military, civilian, etc.).

The distribution of authorized manpower to units by AFSC and grade is determined by the MAJCOMs based upon Air Force standards and guides, the Air Force's Grades Program,[5] and individual management preferences. This process can take several months. TOPCAP uses a Skill Projection Model (SPM) to provide personnel planners and programmers with information about the expected skill and grade allocations by AFSC before the MAJCOM decisions.[6] The projected authorizations for skill levels 7 and 9, along with projected loss rates and skill-level upgrade rates, are then fed into the Objective Force Model (OBFOR).

OBFOR is one of several models used by personnel planners to develop the Air Force's steady-state objective force. The model deals only with the career force (those with more than four years of service). The output specifies the number of career enlisted personnel in each Career Progression Group (CPG)[7] by year of service and two skill

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[5] The Grades Program is derived from the aggregate grade structure described below. See also Sec.7.1.

[6] The SPM has not been run in the last several years. Instead, projected skill and grade allocations from base-level Unit Manpower Documents or those for the previous fiscal year are used by planners and programmers.

[7] CPGs are groupings of AFSCs related by function and career progression.

categories: (1) the sum of skill levels 7 and 9, and (2) skill level 5. The basic premise of the model is that the career force should have enough airmen in the higher skill category in each occupation to meet authorizations, and enough career airmen in skill-level 5 aggregated over all occupations to sustain the total 7/9-level requirement in steady state. (It is assumed that additional 5-level requirements are met by the noncareer force.)

To provide a leadership and pay structure within the skill-level structure, requirements for enlisted members at various skill levels are translated into a grade structure. The size of the steady-state objective career force,* together with a specified end strength, determines the percentage of the enlisted force in each grade E-4 to E-9. Next, the Static (or Airman Force Steady State) Model can be used. It takes as input the size of the objective career force from OBFOR, the grade distribution from the formula, cost factors, and total end strength. It produces a profile of the force by grade and years of service (YOS), promotion parameters (such as average years of service at promotion), and the cost of the steady-state objective force.

The Dynamic (or Promotion Flow) Model is an inventory projection model that simulates the annual force structure (grade by YOS) for several years into the future. It is used to check progress toward TOPCAP goals and to develop a plan for moving the personnel inventory toward the objective force. The Static and Dynamic Models are used iteratively until a desirable steady-state objective force and transition plan have been agreed upon.

The Airman Skill Force Model (ASKIF) disaggregates the inventory by occupational specialty. Personnel programmers use it to project enlisted force characteristics by AFSC for a three-year period (current year, budget year, and the first planning year). It generates a comparison of these projections with the corresponding set of current and expected manpower authorizations, which is used in determining management actions that will produce a good match between the inventory and the authorizations. Among the information listed on the output reports from ASKIF are the needed production of trained personnel from

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* The Air Force calls this number the Career Force Objective (CFO).

basic training and from retraining, reenlistment requirements, and information to evaluate progress toward TOPCAP objectives. Many of these numbers are calculated outside of the model by a largely manual process and are provided as input to ASKIF.

Two other inventory projection models are routinely used by personnel programmers. The Airman Inventory Projection System (AIPS) provides short-term projections. It ages the inventory of airmen from any given point to the end of the fiscal year. Its estimates are used as inputs to the Budget Estimate Submission. The Airman Force Program and Longevity Model (AFPAL) is an aggregate model that is run weekly and monthly to obtain quick estimates of inventories (by grade and TFMS) for the current operating year and nine years beyond. It is used for budget estimation and for budget and end-strength management.

All of the TOPCAP models that project future force structures (e.g., OBFOR, Static, Dynamic, and ASKIF) require retention rates or loss rates as inputs. The Airman Loss Probability System (ALPS) produces annual transition probabilities for each of 18 categories of losses and for reenlistments and extensions. Applying these probabilities to the existing inventory, it also projects the number of losses likely to happen in the following year.

ALPS predictions are based solely on experience during the preceding 12 months. The inputs are (1) the current Uniform Airman Record (UAR) file, (2) a one-year-old UAR file, (3) records of all promotions, demotions, gains, and losses during the last 12 months, and (4) next year's expected nonprior service accessions by month. The output includes loss rates and reenlistment rates for each AFSC by grade and by YOS. Output tapes are prepared for the other TOPCAP models. In addition, data are provided to compare the actual loss rates over the past year with the previous year's predictions and to analyze trends over the last three years in both predictions and actuals.

2.3. PROBLEMS WITH CURRENT SYSTEM

Investigation of the models and methods that the Air Force currently uses for managing its enlisted force gave us considerable appreciation of their sophistication and basic soundness. However, by evaluating TOPCAP and comparing it with the systems used by other armed services, we identified a number of areas in which considerable improvements appear to be possible. Below we list problems that pertain to the entire system. Problems with specific portions of the current system are discussed in the sections devoted to those subsystems. The criticisms we raise here and elsewhere primarily concern deficiencies in the way TOPCAP philosophy has been translated into practice, not deficiencies in the TOPCAP philosophy itself.

- Lack of System Integration and Consistency. Although, as described above, the current system may appear to be unified, integrated, and coherent, it is not so in practice. Most of the integration and consistency it has depends on a few people paying personal attention to these matters.
- Time Delays. To be most useful to those involved in managing the enlisted force, information and analytical results should be available to them when they need it. The information flows and data management procedures in TOPCAP often result in long time delays.
- Multiple Computers. The TOPCAP models are spread over three geographically dispersed computer systems,[9] with no direct (computer-to-computer) links. This leads to time delays and data base management problems.
- Focus on Career Force. TOPCAP is essentially a plan for management of the career enlisted force. It was designed in this way primarily to maintain promotion flow in the TOPSIX grades. However, many personnel plans, policies, and problems center around the initial procurement and management of the first-term force, and individuals in this category make up almost half of the total force.
- Inadequate Attention to Personnel Costs. Personnel costs play a minor role in current personnel planning and programming decisionmaking. Only the Static Model acknowledges costs explicitly. Its output may (optionally) include cost estimates

[9] The computers are located in the Pentagon, at Randolph Air Force Base (San Antonio, Texas), and at the San Antonio Data Services Center (San Antonio, Texas).

for procurement and training, maintenance, retirement, and incentives. But this capability has been "added on" to the basic program and is little used.

- Future Loss Rates Based Solely on Past Rates. There is an implicit assumption in the TOPCAP models that future loss patterns will be the same as the patterns during the past year. The system includes no routinely used models for predicting the effects of policy changes or external conditions on loss rates.

  Loss rates depend on such things as basic compensation, bonuses, promotion opportunities, retirement options, and civilian opportunities. The current system provides no support for the analyst trying to assess, for example, the effects of a change in bonuses or in the unemployment rate on loss rates. If someone is willing to predict the effects (supply the system with loss rates to use instead of the ALPS loss rates), the system's models will use these predictions in projecting future force structures.
- Little Documentation and Maintenance. Documentation of the TOPCAP models is largely nonexistent and there is no central group responsible for maintaining all of the models. As a result, the models are rarely updated to reflect changed situations.
- Limited Gaming Capabilities. One of the most important potential uses of the TOPCAP models is to examine the implications of alternative parameters and policies. However, many of the models are difficult to use in this manner, and even those that are designed to facilitate such "gaming" activities (e.g., Static) are rarely used that way.

3. GENERAL DESIGN PRINCIPLES FOR THE EFMS

The EFMS will be a computer-based system whose purpose is to support members of the manpower and personnel community in carrying out their decisionmaking and information processing responsibilities. It will be designed to improve the effectiveness and efficiency of enlisted force management in the Air Force. To be most helpful in these regards, it should possess certain characteristics. In this section we briefly discuss some of the principles that will guide the design of all aspects of the system. (Other principles will be used in designing specific portions of the system--e.g., a specific module. These principles will be discussed when the specific portion is being discussed.) We also discuss some of the implications of these principles for the system's hardware, software, and support.

3.1. IMPROVE THE MANAGEMENT OF THE ENLISTED FORCE

The EFMS will apply design principles articulated over the last few years by researchers and practitioners who have been involved in the development and implementation of management information systems and decision support systems. The many dimensions along which the new system will improve on the current system include providing:

- Previously unavailable information (or information that was difficult to obtain). This information might be anything from raw data to the implications of a new policy.
- More timely information.
- Better ways to access, display, or understand information.
- Better predictions of airman losses and improved methodologies for forecasting force structure.
- Better tools for developing and evaluating alternative policies.
- Automation of manual calculations whose sheer volume impedes the evaluation of information and the decisionmaking process. This will free some persons to do more productive work, reduce errors, and speed up the system.

- Coordination and integration for the entire enlisted force management process.
- Better ways to explain the planning and programming decisions to others (and better support for these decisions).
- Better capabilities for monitoring the behavior of the force and responding to changing conditions and circumstances. This includes feedback to measure how well management's objectives are being attained, methods for investigating deviations to determine their causes, and a means of correcting unsatisfactory performance or adjusting plans in light of altered conditions.

3.2. COORDINATE, INTEGRATE, AND UNIFY THE SYSTEM

Because the EFMS will not be designed to support all activities related to enlisted force management, it should include interfaces with the activities outside the system (e.g., the new Skill Projection Model, PROMIS, the Pipeline Management System). The interfaces should be both convenient and adaptable to changes in the other systems. Where extensive amounts of information must be transferred from or to the EFMS, the interface should include a direct data link.

For internal consistency and integration, the following characteristics are desirable.

- A common, centralized, integrated data base for the use of all of the system's modules to ensure consistency of results.[1] The data base will retain all relevant information for reports, inquiries, and input to modules in an organized, systematic manner. It will draw its data from several sources, both internal and external to the Air Force. Information generated by one module will automatically become available to all other modules requiring that information.

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[1] Although the components of the data base should be logically integrated, they need not be physically integrated.

- A common high-level programming language for the modules to facilitate updating and maintenance.
- A set of interfaces to those enlisted force management functions that are not directly supported by the EFMS.
- A single office that is responsible for system management, including creating and updating the data base, maintaining and modifying the modules, preparing and maintaining documentation of the system's data files and modules, and training users of the system.

3.3. PLACE USER IN CONTROL

TOPCAP emphasizes computer models more than the decision processes that they were designed to support. The EFMS will be built around the enlisted force managers and analysts in the manpower and personnel community and will be responsive to their needs. It will mesh the analytic power and technological capabilities of the computer with the judgments, needs, and problem-solving processes of the managers and analysts--thereby extending their capabilities, but not replacing their judgment.

As shown in Fig. 3.1, the end user, not ADP support personnel, will be at the controls of the EFMS. Through a command language he will interact with both an integrated data base and an interlinked system of modules (small, flexible, computer-based models). Because the user will typically not be a computer programmer, the command language should be human-oriented instead of computer-oriented. It should be easy to learn and easy to use. The user, without the help of a programmer, should be able to

- request information from the data base
- change data in the data base
- specify parameters and input data for a module
- run a module
- tailor output reports (e.g., in terms of scope, level of aggregation, time period covered, and format).

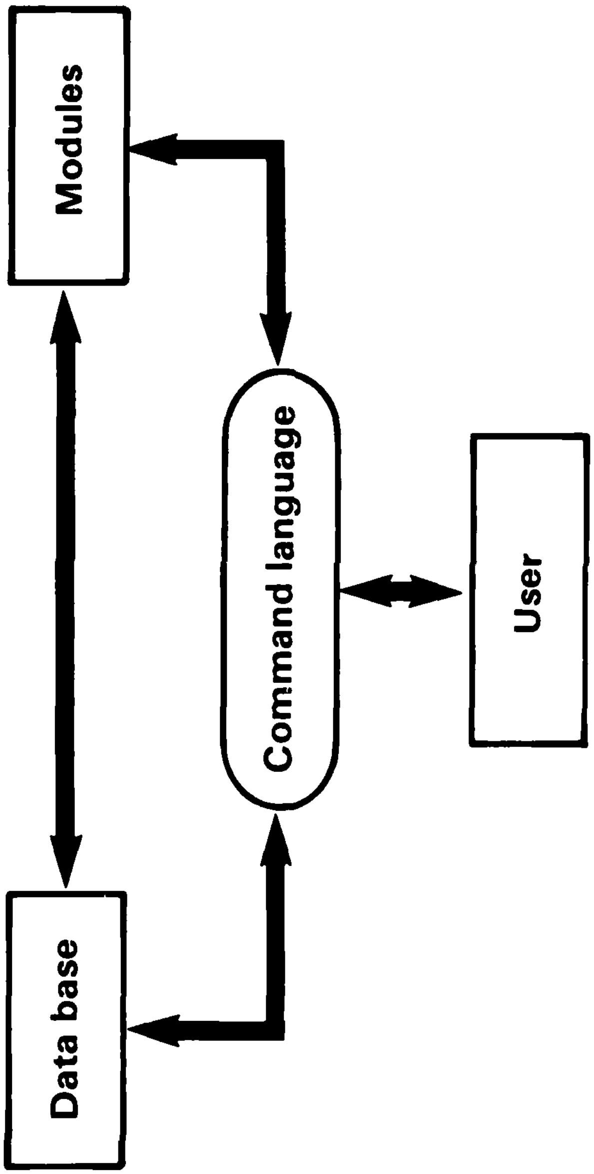

Fig. 3.1 — Major elements of the EFMS

Use of a common command language throughout the system will also serve to coordinate and integrate its many pieces.

To permit its most effective use in creative planning and analysis, the system should also respond quickly to user requests. These activities are inherently interactive, investigative processes in which intermediate results suggest the direction for subsequent analyses. Experience with both batch and interactive modes for planning studies strongly suggests that on-line access to models and data facilitates their most effective use as creative planning tools.

The capabilities described above suggest that the system should be able to provide:

- on-line access to the modules
- on-line access to the data base
- facilities for the statistical analysis of data
- flexible report generators
- graphical displays.

In this man-machine system, the machine will act as man's servant. If the user does not desire to adjust parameter values or specify new input data, the system will supply default values. However, the user will be able to override any of the default values. In addition to the official, common data base, each user will have his own working storage area in which he can store test data, data that reflect hypothetical situations, or data that refer to policies being evaluated. The system will include security and monitoring procedures to insure the integrity of the data base, prevent users from making unauthorized changes, and allow specific users to have access to appropriate portions of the data base.

The modules will have two modes of operation: <u>gaming</u> and <u>operating</u>. The gaming mode will be used for exploratory, "what if" analyses. In this mode, planners and programmers can project the effects of alternative policies and of assumptions or parameters without changing the central data base. If a model is run in the operating mode, there will be controls on the parameters and assumptions that can be used as inputs, and the results will affect the common data base.

3.4. MAKE SYSTEM FLEXIBLE, ADAPTABLE, AND EASY TO MAINTAIN

When first implemented in the early 1970s, TOPCAP was the most advanced, sophisticated enlisted force management system among the U.S. armed services. However, some of its models have fallen into disuse and others have come to reflect reality less and less well. This has happened in large part because the TOPCAP models were not flexible, adaptable, and easily maintained.

The EFMS will be designed to be easy to modify to meet changing needs, knowledge, and situations. It should be able to deal with unanticipated problems, accept new policies, and adapt as circumstances change. For the data base, this means that procedures must be established for continual updating. Policy models often fall into disuse because the input data gradually become out of date, and it is costly and inconvenient to collect the required new data on an ad-hoc basis.

For the modules, this means that they must be flexible (easy to change and revise), reshapable (permit the use of new variables), and dynamic (amenable to revision in response to changes in the data on which they are based). This requires that they be well documented and easily updated. Updating procedures should be incorporated in the routine maintenance of the system so that changes are made to the modules to match changes in the environment. Some changes can be made automatically--e.g., changes in the input data and new parameter values that are calculated from information in the (continually updated) data base.

Flexibility and adaptability will also be made easier by the use of several small, simple modules instead of a few large, complex models. The modules should be able to be more easily modified to analyze new situations or answer new questions in a dynamic environment.

Another design principle that will make the system easy to update and maintain is to make the data required by the modules as easy to obtain as possible. The input data should not require extensive preparation or previous analysis and should be routinely collected by the Air Force or some stable external source (such as the Census Bureau or Department of Labor).

4. OVERVIEW OF THE PROPOSED EFMS

4.1. FUNCTIONAL SUMMARY

The objective in managing the enlisted force is to provide a group of airmen that is best able to support the missions and operational programs that the Air Force must execute. This is an iterative, continuous task, for the Air Force's needs and resources change in response to Congressional, Presidential, and OSD decisions, decisions by the Air Force, and exogenous labor market forces. The task is becoming increasingly difficult as the technology of weapons systems becomes more sophisticated and as budget pressures force the Air Force to make more effective use of its resources.

The Air Force breaks the tasks related to enlisted force management into three functional areas: "manpower," which is associated with determining manpower requirements and allocating the authorizations obtained through the PPBS process; "personnel," which is associated with managing personnel in the organization; and "training," which is associated with properly training (or retraining) Air Force personnel. The manpower functions at the Air Staff level are the responsibility of the Directorate of Manpower and Organization (MPM). Policymaking with respect to personnel planning and programming is carried out by both the Directorate of Personnel Plans (MPX) and the Directorate of Personnel Programs (MPP). Implementation of these plans and programs is the responsibility of the Air Force Manpower and Personnel Center (MPC). Most of the formal military and technical training is provided by the Air Training Command (ATC).

The primary purpose of the EFMS will be to support many of the functions related to the enlisted force that are carried out by MPM, MPX, and MPP. There will be interfaces between the EFMS and the computer systems used by MPM, MPC, and ATC, which will permit the EFMS to obtain inputs from these systems and to supply information to them. Figure 4.1 is a simplified flowchart of the EFMS, which shows the system's major components and indicates its most important inputs and outputs. (A more detailed flowchart of the system appears in the appendix.)

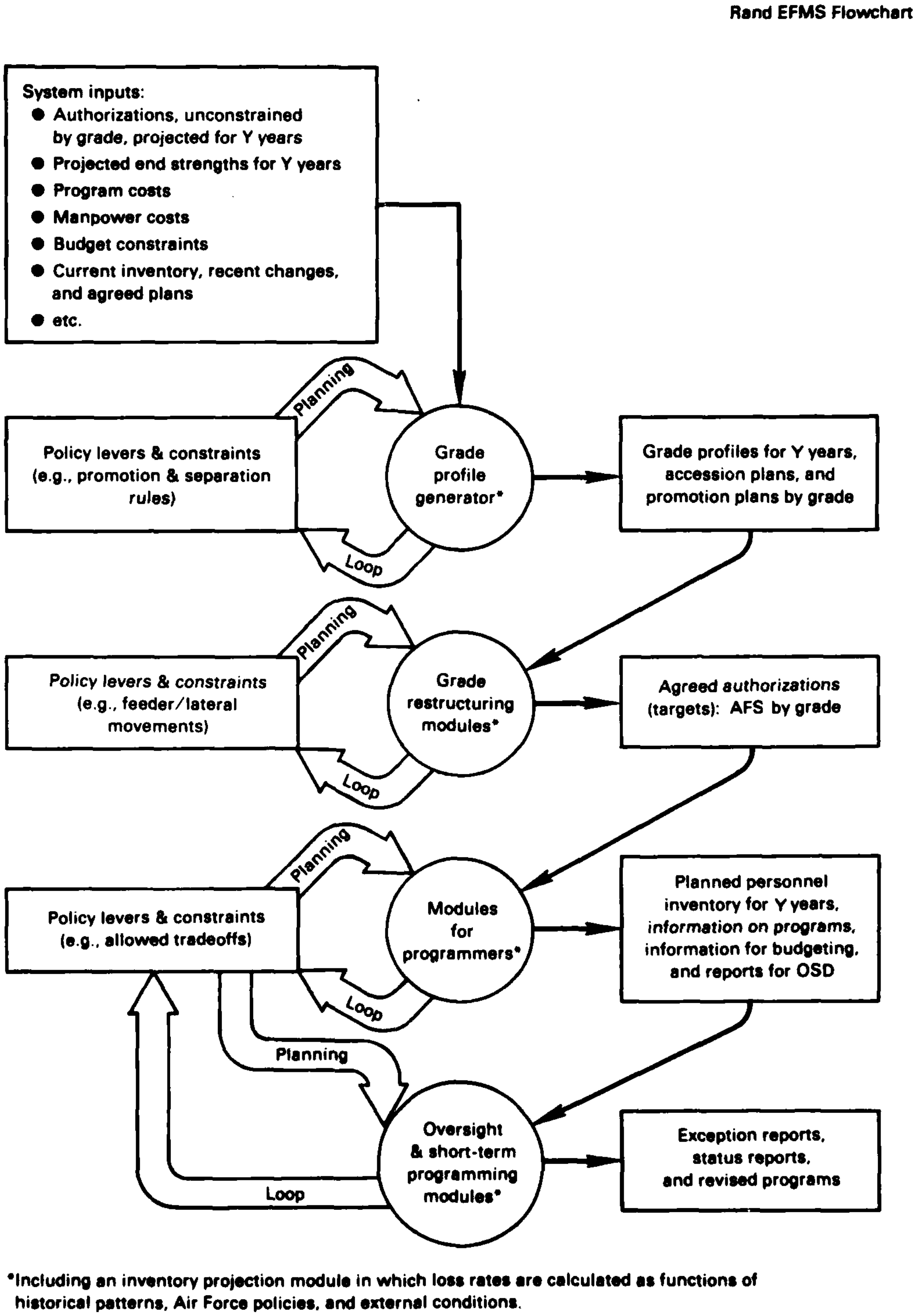

Fig. 4.1 — Summary flowchart of the EFMS

The system is made up of

- four major sets of computer programs (each set composed of one or more modules)
- planning loops involving each set of programs, in which policies, parameters, and constraints used in the modules can be varied and their differential effects assessed before final personnel decisions are made
- several inputs from outside the system (some of which come from direct links with systems maintained by MPM, MPC, and ATC)
- output reports for members of the Air Staff and OSD, and output data files for use by all the modules in the system (and use by other manpower and personnel systems).

The major set of inputs to the system are projected end strengths and counts of authorizations by required grade (called "authorizations unconstrained by grade" in the flowcharts and elsewhere in this Note) for Y years into the future (probably for the operating year, budget year, and the five years of the POM). These come from MPM (either through their 7102[1] file or from a new Skill Projection Model). They include authorizations by Major Command, broken down by AFSC and grade. Another major set of inputs is the current inventory (an extract from the Uniform Airman Records maintained by MPC), recent actual experience (e.g., accession pipelines and training pipelines), and agreed plans (e.g., for future NPS and PS accessions and for lateral and feeder movements). Other inputs needed by one or more of the system's modules include program costs (e.g., training costs), manpower cost factors, and budget constraints.

Some of the inputs will change infrequently (e.g., lateral/feeder relationships). Others will be continually changing (e.g., the current inventory). Schedules and procedures will be established for creating

[1] The 7102 file, which is maintained by the Directorate of Manpower and Organization, contains manpower requirements and authorizations by command, base, and unit in support of the FYDP. Authorizations include AFSC, required grade, and authorized grade for each position.

the various subfiles and for updating the various data elements in the data base. Adherence to these schedules and procedures will be one of the major functions of the office responsible for managing the system. The inputs prepared by the system manager will be the default values for all of the system's programs. Users will be able to override any of the default values if they wish to (and are authorized to do so).

The Grade Profile Generator (GPG) will include a module that will determine a promotion plan (i.e., promotion management parameters) given a set of rules and restrictions, and a long-term aggregate inventory projection module for projecting the structure of the force any length of time into the future.[2] The Grade Profile Generator will be able (1) to develop grade profiles for the future, given projected changes in authorizations, and (2) to analyze changes in the methods by which promotions are determined (e.g., changes in WAPS).

Among the many outputs from the GPG (most of which will be able to be displayed on a computer terminal) are the projected grade profiles (years of service by grade), NPS accessions, and career force entries for Y years into the future, promotion management parameters by grade (e.g., select rate, promotion opportunity, and phase point), and the manpower costs implied by the grade profiles. The GPG will allow the user to vary inputs, such as promotion and separation rules, planned PS accessions, and future military compensation in order to examine the effects of various policies. Once a set of plans is agreed upon, the final outputs (e.g., grade profiles, accession plans, and promotion plans) and the assumptions that generated those outputs (e.g., grade restrictions and separation rules) will be stored on the central data base for use by all of the other modules in the EFMS. Section 6 provides a more detailed description of the conceptual design for the GPG.

[2] The EFMS will include a number of inventory projection modules (IPMs). They will be distinguished by the time horizon for the projections (short term, middle term, and long term) and by the degree to which their output is aggregated (aggregate, which refers to the entire enlisted force or large sub-groups, and disaggregate, which means that projections are provided for AFSCs). A more complete description of the system's IPMs, and the loss models that support them, is provided in Sec. 5.

The agreed grade plan is transmitted to MPM, where, in a process that involves the MAJCOMs, authorized grade structures consistent with the grade plan are developed. The Grade Restructuring Modules (GRM) will assist MPM in distributing grades consistent with mission needs, Air Force ceilings, and constraints inherent in the personnel structure of the Air Force--the GRM mediate the inherently conflicting demands of mission requirements and personnel constraints. The GRM are likely to include:

- a long-term disaggregate inventory projection module[3]
- a module to determine a preliminary allocation of grades among specialties based solely on required grade counts
- a module to adjust the allocation of grades to specialties that considers personnel policies
- a module to estimate the personnel programming effects (e.g., training requirements) of a given allocation of grades among specialties
- a module to allocate grades to MAJCOMs.

Among the several important outputs from the GRM are the implications for personnel programs of the new allocation of grades, a description of the experience level of the force, and projected personnel costs. The authorizations with restructured grades that are obtained from the GRM become the targets for MPP's programming activities and MPC's assignment activities. The Grade Restructuring Modules are discussed in detail in Sec. 7.

The Modules for Programmers (together with the Oversight and Short-Term Programming Modules) constitute what MPP has labeled the Enlisted Programming System (ENPRO). The distinction between the two sets of modules lies primarily in their time horizon. The Modules for Programmers are concerned with supporting programming decisions as far away as the last year covered by the Program Objective Memorandum (up to seven years into the future). The modules in the last set focus almost exclusively on the remainder of the current fiscal year.

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[3] This module will project the behavior of an ideal force rather than the expected behavior of the current inventory.

The purpose of these two sets of modules is to help personnel programmers meet the goals established by the requirements determination, personnel planning, and grade restructuring processes. If these goals are to be met over the course of several fiscal years, many programming options are available, including bonuses, tiered promotions, training programs, etc. The Modules for Programmers will help the personnel programmer consider tradeoffs among the various options in order to choose a set of programs that is projected to provide a good fit to the manpower targets (as established by the GRM) at a reasonable cost.

Among the Modules for Programmers will be both an aggregate and disaggregate inventory projection module, a module to detect AFSCs with projected overages and shortages by grade and year of service, and modules for calculating the levels of various programs. The modules will produce several kinds of outputs. The major outputs needed to support the process of program selection are descriptions of the program options being considered, projections of the inventories that would result if those programs were implemented, and costs. Once the programming decisions are made, the modules will produce many additional outputs, including the TPR, reports for OSD, and information for use in budget preparation. A more complete description of the Modules for Programmers is given in Sec. 8.

The Oversight and Short-Term Programming Modules track the progress being made toward the established targets, warn of projected deviations from targets, and provide support for choosing programs that will attempt to correct the projected deviations. Their major emphasis is on achieving the personnel objectives for the current fiscal year, such as meeting the end strength requirement and staying within budget constraints. Within this time horizon (less than 12 months) the programming options are limited to changes in accessions, separation, and training plans.

The modules in this set include short-term aggregate and disaggregate inventory projection modules, a module to compare the short-term projections with various targets, and modules for calculating tradeoffs among the short-term programming options. Among their outputs are exception reports, which are produced automatically whenever the comparison module detects an unacceptable deviation from a target;[4] status reports, which provide information on the force in the current month, any desired previous months, and cumulatively for the fiscal year; information for evaluating the short-term programming options being considered; and suggested TPR amendments and other changes in plans that result from the programming options selected. More information on the Oversight and Short-Term Programming Modules is given in Sec. 9.

4.2. A COMPARISON OF THE EFMS WITH TOPCAP

The proposed EFMS represents an evolutionary (not revolutionary) change in the way the Air Force manages its enlisted force. Many of the features of the current system were found to be working well and were retained. In particular, the underlying philosophy of TOPCAP has been retained, the general flows of information in the system will be undisturbed, and the organizational roles and responsibilities will be almost entirely unchanged. In designing the EFMS, our primary goal was to overcome as many of the current system's problems as possible. Of course, the proposed system does not overcome all of the problems, but it should remedy the ones that are contributing most to reducing the system's efficiency and effectiveness.

4.2.1. Features Retained

In designing the EFMS we made a distinction between the TOPCAP philosophy and models. The TOPCAP philosophy is very sensible. Among all the armed services, the Air Force pays the most attention to the needs and desires of its personnel. TOPCAP is a personnel-oriented system, and the EFMS will have the same orientation. In particular, it will incorporate TOPCAP's guiding principles:

- Equal selection opportunity (with the option of having multi-tier promotion policies)

[4] The user will specify situations under which the system should produce an exception report.

- A visible and stable career-progression structure
- Year-group management.[5]

The existing organizational structure for enlisted force management--with separate directorates responsible for determining manpower requirements, personnel planning, personnel programming, and personnel assignments--may or may not be the best structure possible. However, it is certainly a reasonable way of splitting up the functions. One major problem with this structure is that MPM, MPX, and MPP tend to operate as separate entities, with few lines of communication across organizational boundaries. The EFMS should provide more unity and cohesion to the system and therefore help to mitigate this problem.

The EFMS will not affect the major flows of information in the system.[6] The problem with the current system is not that the information flows are wrong, but that time delays are long and that information used in various parts of the system is invalid, unreliable, or inconsistent. The EFMS design addresses these problems.

Finally, we are not proposing to change any of the computer systems that are working well. Many of the subsystems supporting enlisted force management have been developed recently and are not in need of replacement or overhaul. Among these subsystems are PROMIS, the Pipeline Management System, and the Career Airman Reenlistment Reservation System. The EFMS will be designed to be compatible with these subsystems and to have direct data links with them where desirable.

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[5] At any given time, an individual's year group is defined by his TAFMS. Many of the Air Force's personnel policies pertain to year groups.

[6] Except for some changes in the models, the information flows shown in Bruce Armstrong and S. Craig Moore, <u>Air Force Manpower, Personnel, and Training: Roles and Interactions</u>, The Rand Corporation, R-2429-AF, June 1980, p. 27 (Fig. 9), will remain largely unchanged.

4.2.2. Problems Overcome

The EFMS has been designed to eliminate or mitigate most of the sources of inefficiency in the current system and to provide tools that will improve the quality of the decisions made by personnel planners and programmers. The biggest improvements in efficiency will result from computerizing many of the activities that are currently performed manually and integrating the system's data processing activities (with a centralized data base and direct computer links with other subsystems).

The biggest improvements in the quality of the decisionmaking will result from improving the quality of the loss projections. The ALPS projections, which are used for a multitude of purposes in the current system (including many for which the ALPS methodology is not appropriate), will be replaced by projections that are calculated by a number of different loss projection models. Each model will be tailored to the specific needs of the EFMS module that will use the projections. In addition, unlike ALPS, whose projections are unaffected by changes in the environment, the loss models in the EFMS will take into account external economic conditions and internal Air Force policies in predicting losses.

The quality of decisionmaking will also be improved by providing the decisionmakers with more and better information in a manner that is more useful to them and that is more timely. Two additional types of information to be provided are:

- Expanded cost information. Included will be direct manpower compensation (e.g., annual costs and the cost of an airman over his term of service) and program costs (e.g., the costs of training and retraining).
- Information on the total active enlisted force. Most of the TOPCAP models restrict their attention to the career force. All EFMS modules will permit examination of the entire active enlisted force. Among other advantages, this will enable personnel planners to examine the feasibility of attaining sufficient numbers of career personnel.

By integrating personnel planning and programming activities through a common, continually updated data base and consistent models, the EFMS will improve the quality of the data used throughout the system, and will assure consistency in the resulting plans and programs. The use of on-line interactive terminals for retrieving information and running models, and the ability to use all models in a gaming mode, will enable users to obtain results faster than is currently possible, and to examine more alternatives before making their decisions. These capabilities also increase the flexibility of the system and make it easier to adapt to changes in policies and procedures.

5. INVENTORY PROJECTION AND LOSS MODULES

5.1. INTRODUCTION

One of the most critical needs of programmers and planners responsible for management of the enlisted force is accurate projections of the inventory of airmen. These force projections drive decisions in such key areas as recruiting, training, and bonus management. Sometimes the need is for detailed forecasts over a short period, such as the numbers of airmen by AFSC by grade for each of the remaining months of the current fiscal year. Other times, less detail is required, or a different time horizon is important.

Programmers are chiefly concerned with the behavior of the current force in the current milieu of opportunities and requirements; their time horizon is commonly a few years and seldom stretches beyond seven. Planners, however, wonder how the force might evolve if a different mix of airmen made up the force, or if new retirement benefits or other incentives faced the airmen; their time horizon may stretch to many years.

Formal models for making the inventory forecasts required by programmers and planners are called Inventory Projection Models (IPMs). Such models take an initial actual or hypothesized inventory of airmen and "age" the inventory to predict what the force will look like in the future. The complexity of an IPM will largely depend on the accuracy and detail with which one wishes to describe future inventories. For example, to accurately predict the distribution of airmen by AFSC by grade in future inventories may require submodels that account for both retraining and promotions, but to predict the size of the total force may require neither.

In either case, the IPM must contain a loss model that predicts how many members of the current inventory will leave the service by the future period in question. The "heart" of any IPM is its loss model. In fact, any IPM can be viewed as a system for simulating changes in the enlisted inventory with an embedded loss model that supplies the predicted loss rates needed to update the system.

No single IPM is likely to serve all users equally well; the needs of users are simply too varied. Budgeting, planning for meeting end strength, predicting the effects of new compensation schemes, etc. all require different degrees of detail and different time horizons. Tailoring individual IPMs to specific needs is likely to provide better and simpler service to each user.

The Air Force currently uses several inventory projection models. For example, MPP uses the Airman Inventory Projection System (AIPS) to develop the Budget Estimate Submission produced each October. This IPM ages the current inventory of airmen, by individual, up to 15 months. The Airman Force Program and Longevity Model (AFPAL) is used by MPPP for budget estimation and for tracking information needed to take control actions to remain within budget and manpower authorizations. AFPAL yields counts of losses by grade and years of service, accounts of dependent and retirement data, and projected many years by pay category. Its projections are for the current operating year, the upcoming budget year, and eight additional planning years. (AFPAL also compares its projected inventories with desired or authorized strengths and shows consequent recruiting and promotion quotas.) The Dynamic Model is used by MPX to project the total aggregate force by grade and year of service into the future. It is used to develop a plan for moving from the current inventory toward the objective force structure.

One striking feature of these three IPMs is that despite their differences in time horizon and degrees of aggregation, they all rely on ALPS, a loss model for predicting the kinds and numbers of airmen who will leave the service. It is the inherent limitations of ALPS that account for the most serious inadequacies of these IPMs.[1]

ALPS predicts loss rates for various categories of airmen based solely on the observed loss rates in the previous year. This approach works well when the domestic economy and the Air Force's personnel policies remain fairly stable. But in the face of external economic changes (for example, greater civilian unemployment) or internal structural changes (for example, higher military compensation), the ALPS forecasts are likely to mispredict future retention rates markedly.

[1] Manual overrides of the ALPS probabilities are often made.

Because neither the civilian economy nor military personnel policies have been very stable in the recent past, and neither is likely to become very stable in the near future, the ALPS methodology is an inappropriate one to use in specifying IPMs.

Furthermore, ALPS is needlessly cumbersome for the needs of many IPMs. ALPS assigns a probability of loss to each airman in the current inventory. This degree of disaggregation is far greater than required by some IPMs.

The EFMS will contain several IPMs, each tailored to a specific need. Each IPM will obtain loss projections from one or more loss models. Except when predicting only a few months into the future, predictions from the loss models will be based on expected economic conditions and anticipated Air Force policies, such as promotions and bonuses. The loss models will be estimated from historical data that describe how loss rates have varied in response to economic conditions and policy changes. Therefore, if regularly maintained and reestimated, they will be able to predict how future circumstances and policy changes will affect the inventory.[2]

5.2. INVENTORY PROJECTION MODELS IN THE EFMS

There will be six inventory projection modules in the EFMS. Each module will have its own time horizon (short, medium, or long term) and level of aggregation (aggregate or disaggregate), dictated by the module's function. Underpinning each of the IPMs will be a loss model that shares the IPM's time horizon and level of aggregation and that accounts for external and internal changes that could influence retention behavior.

Short-term IPMs will forecast monthly inventories from the present to about one year in the future. Middle-term IPMs will forecast monthly inventories up to about seven years in the future. Long-term IPMs will forecast monthly inventories for any number of years. (The following subsection provides a more detailed discussion of time horizons.)

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[2] An extract of historical data about the enlisted force will need to be maintained and regularly updated for this purpose.

IPMs will provide either aggregate or disaggregate inventory forecasts. Aggregate forecasts will project the number of airmen by grade and year of service. Disaggregate IPMs will project the number of airmen for each AFSC by grade and year of service.

The Grade Profile Generator requires a long-term aggregate IPM model that can take an actual or hypothetical aggregate description of the inventory of airmen at a moment in time and yield monthly projections of the future inventory by grade and year of service.

The Grade Restructuring Modules require a long-term disaggregate IPM that can take hypothetical data about an idealized inventory of airmen and yield projections of the future inventory for each AFSC by grade.

The Personnel Programming Modules (ENPRO) require two IPMs. One is a middle-term aggregate model (primarily used for budget preparation and budget management), the other is a middle-term disaggregate IPM.

The Modules for Oversight and Short-Term Programming require a short-term aggregate and a short-term disaggregate IPM that use detailed data about the actual current inventory of airmen to forecast monthly inventories for up to 12 months into the future.

5.2.1. Time Horizons for IPMs and Loss Modules

Predicting whether an airman will reenlist for, say, a third term of service when that decision is eight years in the future is quite different from making the same prediction for an airman who must make that choice within the next twelve months. The task is again different if the airman has just begun a second term of service. Consequently, the temporal horizon of our forecasts will shape the model we use for making predictions. The fundamental differences among such models will be the data available about the airmen whose choices are being predicted.

The short-term loss prediction models will use information about stated intentions. An airman who decides to reenlist informs the Air Force of that decision before the expiration of his time of service (ETS) and frequently months earlier (currently up to a year). Similarly, extensions may occur well before ETS. These decisions are reflected in the airman's record as a change in the date of separation (DOS). The likelihood that a person will separate on his DOS (called an ETS loss) therefore depends on how far in the future the DOS is: because he has had a longer period to reenlist, a person whose DOS is three months in the future has a higher probability of being gone by his DOS than one whose DOS is 11 months in the future (all other factors being equal). Thus, our short-term projections of airman losses will supplement information about traits, specialties, grades, etc. (which is also useful in making longer-term projections) with specific information about when airmen will reach their reenlistment points in the coming months.

In the middle term, the length of time to an airman's DOS is generally less informative than in the short run. Neither an airman with a DOS 18 months in the future nor one with a DOS 30 months in the future has had an opportunity to state his intentions to reenlist, so the likelihood of an ETS loss for each will be the same (again, all other factors being equal).

These differences between the short- and middle-term predictions require that we have separate models for each. The short-term loss prediction model will be used to predict the losses of airmen who are close to their DOS, and the middle-term loss prediction model will be called on for making predictions for the next several years--the period during which stated intentions are not useful predictors, but predictors such as grade, marital status, number of dependents, etc. are still useful. The choice of model will be made automatically by the system.[3]

In modeling long-term losses, we will largely be concerned with projecting the losses of persons who have not yet entered the force. Thus, detailed information about current airmen will not be very useful. We expect that the long-term model will be based on the expected values of a small number of the individual traits of new enlistees.

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[3] The intermediate-term IPMs will use both the short-term and intermediate-term loss prediction models. The mathematical manner in which a transition is made between the two models will be determined by analysis.

5.2.2. Monthly Projections

Most inventory projection modules will predict the number of airmen in each future month of the time horizon. Monthly predictions are a convenient way to get a good picture of the inventory for any future point. (Often, one wants the position at the end of a fiscal year.) In addition, monthly predictions are a necessary input to the modules for oversight and monitoring. To obtain monthly predictions for the short- and middle-term disaggregate IPMs, the EFMS will need more detailed data on the pipeline than is used by ASKIF (the scheduling of ATC and non-ATC courses, class sizes, prior service accessions, etc.).

Although the IPMs will project the inventory month by month into the future, the user will be able to select the time unit(s) appropriate for his analysis. The trained personnel requirements are analyzed with respect to an end of fiscal year position. Selective reenlistment bonuses are set for six-month periods. The number of career job reservations is decided for each quarter. The user will specify the periods of interest and receive output describing the inventory at the end of each such period and all flows (losses, promotions, etc.) that are expected to occur.

5.3. DESIGN PRINCIPLES FOR IPMS AND LOSS MODELS

Eight major principles will guide the development of the inventory projection models and their attendant loss models.

(1) Each IPM will provide output in detail appropriate for the modules of the EFMS that the IPM serves.

(2) All IPMs and loss models will allow explicitly for changes in external economic conditions--in particular, changes in civilian unemployment and civilian wages.

(3) All IPMs and loss models will allow explicitly for changes in military compensation (including wages, bonuses, and retirement benefits), promotion opportunities, and other selected institutional features of the Air Force.

(4) Disaggregate and aggregate IPMs for a given time horizon will be linked so that the losses predicted by the disaggregate model can be required to be consistent with the losses predicted by the aggregate model.

(5) The short-term, intermediate-term, and long-term IPMs will be linked so that projections of losses from the three can be required to blend smoothly together. This feature will enable users to apply each model to the periods for which it is best suited and then combine the forecasts across the models without introducing artificial discontinuities in predicted loss rates at the points where one switches models.

(6) The categories of airmen used in the various loss models will be structured to ensure comparability across the models. For example, it is undesirable to distinguish cooks from band members and technicians in the long-term loss model while lumping together cooks and band members and contrasting them to technicians in the intermediate-term model.

(7) The loss models used will ensure that estimated loss rates cannot be less than zero or more than one. This is a technical requirement that restricts the possible mathematical specifications of the loss models.

(8) Data for the independent variables used in the loss models will be easy to obtain. They must be routinely collected and published or available from standard sources.

5.4. MODELING AIRMAN LOSSES

The inventory projection process is rather straightforward. However, the development of loss models to drive the inventory projections is not. The remainder of this section examines the development of loss models for the IPMs.

5.4.1. Types of Loss Behavior

The loss models must account for three types of behavior:

- Leaving the service without fulfilling one's contractual obligation to the Air Force. (In most instances, this results from the Air Force deeming the individual unfit for further service. In some cases, however, individuals ask the Air Force for relief from the contract.)

- Reenlisting for an additional term of service.
- Extending the current term of obligation without reenlisting.

Figure 5.1 is a stylized picture of the cumulative loss rate over time for a cohort of four-year enlistees who entered the Air Force on a particular date. Although the figure is a greatly simplified picture of the real world (e.g., it leaves out two important features of actual loss rates--PETS losses and extensions--and it assumes that all enlistments are for four years), it nonetheless provides a useful conceptual framework for analyzing losses.

Each time the cohort reaches the end of another term of service (assumed for the moment to be four years), there is a discrete jump in losses as individuals fail to reenlist. Between reenlistment points, and between entry and the first reenlistment point, attrition losses occur continually.

To model losses then, we shall model each of the discrete choices--to reenlist or not--and each of the attrition processes as well.

PETS losses, extensions, and the possibility of both six and four year reenlistments cause actual cumulative loss rates for a cohort of four-year enlistees to be less well defined than shown in Figure 5.1. The divergences of separation dates from the neat 4, 8, 12, etc. year points shown in the figure lead to a smearing of reenlistment points over time and will require more sophistication to model.

We can straightforwardly incorporate extension decisions into the conceptual framework. Airmen do not simply choose to reenlist or leave, they can also extend. Rather than a dichotomous choice, the model allows a trichotomous decision.

Six year reenlistment options simply add one more alternative to the individual's set of alternatives. One must decide not only whether to enlist, but for how long.

PETS losses require that one consider the distribution of actual separation dates about the contractually established date, rather than just analyzing whether or not people leave.

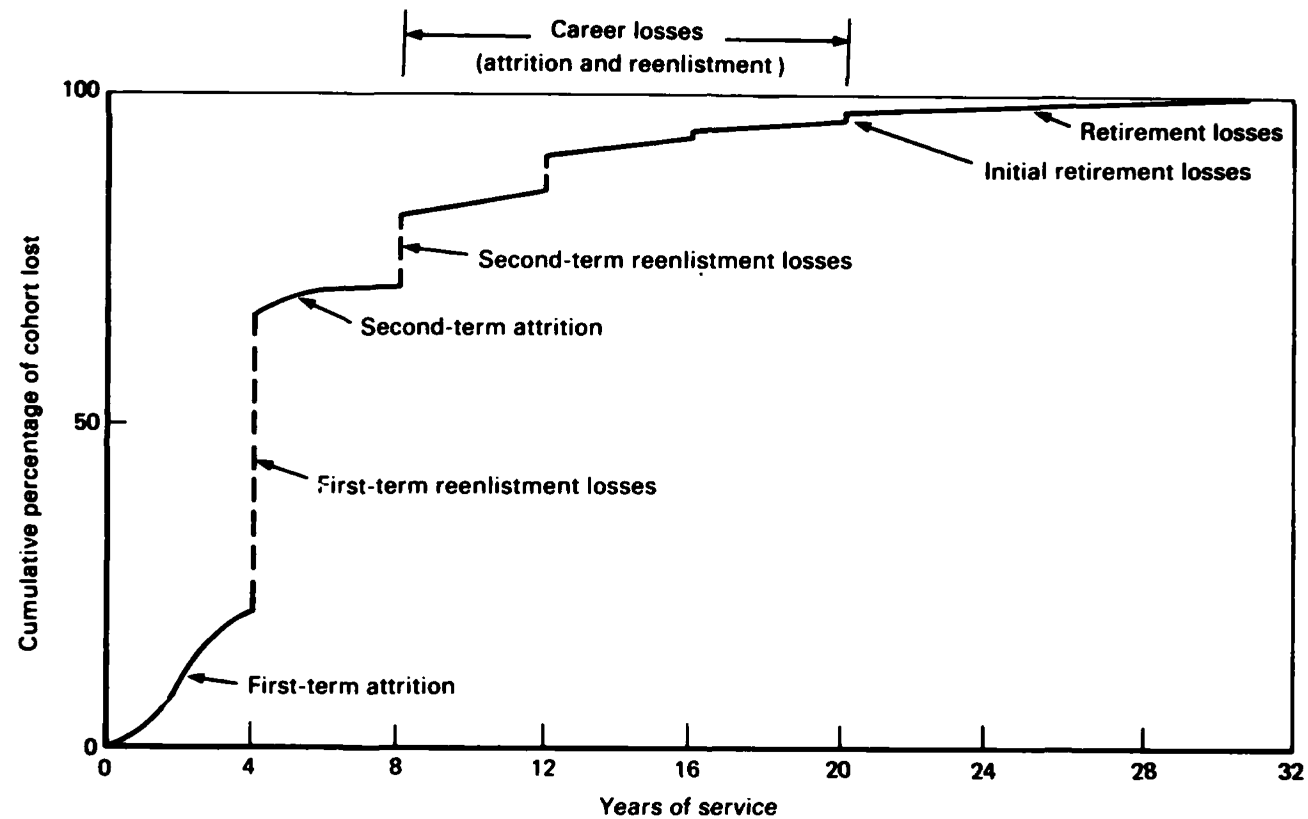

Fig. 5.1 — Cumulative loss rates from a hypothetical cohort of enlistees*

*For purpose of illustration, this simplified representation ignores many aspects of the real world, such as the fact that some airmen enlist for a 6-year term and that many airmen extend before they reenlist or leave the service.

The above considerations call for the loss modules to have the following eight components:

1. First Term Attrition Model
2. First Term Reenlistment and Extension Model
3. Second Term Attrition Model
4. Second Term Reenlistment and Extension Model
5. Career Attrition Model
6. Career Reenlistment and Extension Prior to Retirement Eligibility Model
7. Retirement Model
8. Models for Smearing Losses About Contractual Separation Dates to Reflect PETS activities.

5.4.2. Modeling Attrition Losses

Airmen's inability to complete training successfully is distinguished from all other attrition. The former occurs almost entirely in the first year of enlistment and is largely concentrated around the end of basic military training. The latter generally results from some mishap or cumulation of mishaps and is not concentrated at any one time during an airman's term of enlistment.

Attrition not associated with training can happen any time during a term of enlistment, and it is just this feature that will dictate the initial specification of attrition behavior in the EFMS loss models. We shall assume that an airman with specific traits runs a continuous risk of attrition for nontraining reasons throughout any one term of enlistment. Such a model is called a "proportional hazard" model.

More formally, we shall assume that an airman's probability of attrition for nontraining reasons during some interval of time $[t, t + dt]$ is

$$P = f(X, B)dt$$

where X is a vector of the airman's traits and circumstances, and B is a vector of coefficients. Table 5.1 presents the candidates we plan to consider for inclusion in X.

Table 5.1

KEY VARIABLES FOR ATTRITION ANALYSIS

Education
Race
Sex
Date of enlistment
Age
Marital status
Number of dependents
Term of enlistment
AFQT percentile
Grade
AFSC
Unemployment rate
Civilian wage
Military wage

Popular statistical packages do not contain routines for estimating proportional hazard models, but Rand has its own software specifically developed for fitting such models. To account for unobserved differences among one-term, two-term, and career airmen, we shall estimate separate attrition models for each group.

Attrition associated with training is concentrated in time, and it may therefore not be suitable to analyze this behavior with a hazard model. We shall explore alternative models for capturing this type of attrition after we have conducted preliminary analyses of attrition to ascertain the temporal distribution of training-related attrition in the first term.

5.4.3. Modeling Extensions and Reenlistments

There is an extensive literature of empirical studies that seek to identify the determinants of reenlistment. We reviewed this literature and presented a briefing on it in March 1982. That review summarized the findings of past work, and in Table 5.2 we present the variables that others have found to influence reenlistment behavior. We shall

Table 5.2

KEY VARIABLES FOR REENLISTMENT
AND EXTENSION ANALYSIS
(Based on Literature Review)

Education
Race
Sex
Age
Marital status
Number of dependents
Term of enlistment
AFQT percentile
Grade
Time in grade
Control AFSC
Duty AFSC
Bonus
Spanish surname
Major command area
Unemployment rate
Civilian wage
Military wage

incorporate these into our analysis along with indicators of time to DOS that have been found to be useful for predicting short-term behavior.

Past researchers have limited their attention to the reenlistment decision. In formal terms, they have studied the probability of reenlistment, which is the expected value of a dichotomous random variable, Y, which takes on the value 1 if the airman reenlists and the value of 0 otherwise. Most models have posited that

$$E(Y|X_1,\ldots,X_n) = B_1X_1 + \ldots + B_nX_n \tag{5.1}$$

or

$$E(Y|X_1,\ldots,X_n) = F(B_1X_1 + \ldots + B_nX_n) \tag{5.2}$$

in which the X_i are the traits and circumstances of the airman, and the form of the function F is the cumulative distribution function (c.d.f.) associated with the normal or logistic probability distributions. Models that use the normal c.d.f. are called "probit" models; those that use the logistic c.d.f. are called "logit" models. The introduction of the nonlinearity implied by F complicates estimation, but failure to do so allows predicted reenlistment rates to be less than zero or greater than one, which is obviously undesirable.

The loss models in the EFMS require that we examine more than just the reenlistment decision. We must ask whether airmen extend before they leave or before they reenlist. A straightforward extension of the earlier analyses would be to picture the airman's decision process sequentially. First the airman decides whether he wishes to remain in the Air Force, and then, conditional on the first decision, the airman chooses to extend or reenlist.

Formally, this requires that we add two more equations to the reenlistment decision model. The first would represent the probability of extending before reenlisting, given reenlistment. The second would represent the probability of extending before leaving, given no reenlistment. These equations could be specified as probit or logit models, like the reenlistment equation, using the same explanatory variables.

It may be more fruitful to envision an airman as choosing from among three alternatives each time he approaches his scheduled separation date:

- Reenlist
- Extend
- Leave the service

From this perspective, it may be more reasonable to specify a trichotomous choice function initially, rather than viewing the process sequentially. We shall examine the trichotomous choice extensions of the probit and logit specifications to see if they provide better forecasts than the sequential modeling approach.

One feature that both of the above strategies share is that they examine each reenlistment decision in isolation from all others; they are single-decision models. A more complex modeling strategy is to acknowledge that there are interdependencies among decisions over time and to capitalize on that information in estimating the model. For example, when deciding whether to reenlist for a second term, an airman with no prospect of staying for a third term will weigh military retirement benefits differently from someone who is seriously considering a military career. Consequently, the probability of an airman reenlisting for a second term depends in part on his probability of reenlisting for a third term.

Models that account for these interdependencies across time are called multiple-decision models. Estimating the parameters of such models can be more cumbersome than estimating the parameters of a sequence of single-decision models, but one advantage of multiple-decision models recommends them for our serious consideration. Over the period for which we have data, there have been no variations in the military retirement system for airmen. Without sample variation, it becomes impossible to directly estimate the effects of changes in retirement benefits or losses. However, the detailed *a priori* economic structure incorporated into some multiple-decision models makes it possible to infer the effects of alternative retirement plans by equating the plans to alternative streams of income over time.[4]

Because the EFMS should be capable of assessing the effects of possible changes in retirement benefits (and other changes in YOS/grade structure of pay), we will explore ways of including a multiple-decision loss model in the EFMS. One approach would be to rely on single-decision models for all but analyses explicitly calling for altered retirement plans, in which case we would use a multiple-decision model. The advantages of this approach are that the multiple-decision model would be simplified, because it need account only for retirement benefits, and the analyses of other plans would not have to be forced to conform to the restrictive *a priori* structure inherent in the multiple-decision models.

Whatever choice is made between single- and multiple-decision models, and no matter whether one is examining an aggregate model in which the independent variables are the average traits of the force or a

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[4] See, for example, Glenn A. Gotz and John J. McCall, *Estimating Military Personnel Retention Rates: Theory and Statistical Method*, The Rand Corporation, R-2541-AF, June 1980.

disaggregate model in which the independent variables are the traits of an individual, several questions need to be answered if the loss models are to be properly specified and estimated.

1. What is an appropriate classification scheme for aggregating skill categories?[5] The classification for any one loss model will be constrained by the need for conformity with classifications used in other loss models within the EFMS and with data on civilian opportunities. Moreover, the classifications will have to be intuitively consistent.

2. What is an appropriate temporal lag structure for including economic variables (e.g., civilian unemployment), both realized and predicted?

3. How important are serial correlation and cohort-specific effects?

4. How do "reenlistment losses" depend on the level of attrition already experienced by a cohort?

5. What measures of military compensation predict behavior well?

6. How can we disentangle the interaction between (a) the influence of a higher grade on staying in the force, and (b) the influence of staying in the force on receiving a higher grade?

7. Which of the demographic characteristics being used as loss predictors are stable enough that one can assign mean values to a cell in the inventory (for medium-term prediction), and which characteristics require expansion of the number of cells? We expect that the first-term force will be divided into more cells than the career force.

5.5. DATA TO BE USED IN DEVELOPING LOSS MODELS

The primary data source we shall use in estimating loss models for the EFMS will be the Enriched Airman Gain/Loss (EAGL) file designed by Rand and constructed for Rand by the Defense Manpower Data Center (DMDC) in Monterey, California. The EAGL file combines data from DMDC's master

[5] It would be nice if all differences among occupations in loss rates and the way loss rates respond to policy changes (changes in bonuses) could be expressed in terms of underlying variables that cause the differences (unemployment rates, frequency of tours in undesirable locations, etc.). Although we will be exploring the power of these explanatory variables, we expect that some occupation-specific differences will remain.

files and AFHRL's Airman Gain/Loss file (as cleaned and recoded by the Resources Research Corporation) to provide us with longitudinal histories for each airman who served in the force any time between 1971 and 1981. The EAGL's annual snapshots of each airman's traits and data gathered whenever the airman chose to extend, reenlist, or leave the service provide an ideal foundation for estimating loss models.

We are supplementing the EAGL file with other historical data. With the help of staff members of MPP and MPC, we have already created the following data files:

- ENLISTED PERSONNEL COMPENSATION, 1971-1981

  This file includes monthly basic pay by grade and years of service, basic allowance for quarters by grade, and monthly net take-home pay by grade, years of service, marital status, and number of dependents.

- PROFICIENCY PAY SCHEDULES BY AFSC, 1 July 1970-30 June 1975 (Proficiency pay for medical, dental, and special duty AFSCs extends beyond 1975).

- BONUS PAY SCHEDULES, BY AFSC AND ZONE

  a. Variable Reenlistment Bonuses, 1 January 1971-31 May 1974.

  b. Selective Reenlistment Bonuses, 1 June 1974-current (i.e., as of 1 June 1982).

- AFSC CONVERSIONS, 15 May 1951-31 October 1980

- PROMOTIONS BY GRADE, 1971-1982

  Data include, for each grade and year: number eligible; number selected; percent selected; and average time in service for those selected.

- AVERAGE ANNUAL UNEMPLOYMENT RATES BY SEX, RACE (OR JOB CATEGORY), AND AGE, 1971-1981

- CIVILIAN EARNINGS BY OCCUPATION, 1972 and 1978

  Earnings of persons in the private sector by Dictionary of Occupational Titles (D.O.T.) code and comparable AFSC for 1972 and 1978.

These are the primary data we will need to supplement the EAGL file. As we identify further data requirements, we will draw them from internal Air Force sources or public documents.

In addition to the raw quantified data to be found in computer files and publications, we will rely heavily on the expertise of experienced personnel planners and programmers in the Air Force to provide the institutional details that will lend verisimilitude to the loss models being developed.

5.6. STEPS IN DEVELOPING LOSS MODELS

Each loss model will be developed in essentially the same way:

1. Use the data in the EAGL file to examine historical patterns of losses of various types. This will guide specification of the models. For example, the temporal distribution and reasons for first-term attrition will be analyzed in order to guide the choice of an appropriate statistical model for first-term attrition.

2. Construct linear models to identify important variables and to explore serial correlation, lag structures for economic variables, etc. Although the logit and probit models are preferable to linear models of the form of Eq. (5.1) (because the logit and probit models restrict loss probabilities to the range [0, 1]), they are more costly to estimate. Consequently, we will conduct much of our preliminary analysis with the more tractable linear models.

3. Formulate alternative models for consideration. For example, is the reenlist, extend, or leave-the-service trichotomy better predicted as a sequential process or as a single trichotomous decision?

4. Estimate the parameters for the alternative models from historical data. Once the preliminary inspections of the data have allowed us to narrow our attention to a particular subset of variables and a few alternative functional forms, we shall fit the models chosen for comparison.

5. Evaluate the alternative models. Several considerations must be weighed when choosing among alternatives:

- Fit to Data--within the sample data how much of the variation in loss behavior across individuals or across groups is accounted for by each of the alternatives?
- Quality of Predictions--when the alternative models are used to forecast the behavior of airmen different from those used to fit the models, does one model yield notably more accurate predictions of loss rates?
- Stability over Time--when the alternative models are fit to data for airmen who entered the force at a different time from those used to first fit the models, are the two sets of parameters for one of the models more similar than those of the others?
- Computational Complexity--would refitting one of the modules to new data be less difficult than refitting others? This would imply greater ease in updating the model in the future.
- Complexity of Data Required--would one model require more easily obtained data for refitting in the future than would other models? This, too, would imply greater ease in updating the model in the future.

6. GRADE PROFILE GENERATOR

The enlisted force grade profile is a two-way count of enlisted members by grade and years of service (YOS or TAFMS), without regard to occupational specialty or other characteristics. A grade plan or grade structure is a count of grades without the YOS dimension. Viewed from the planners' perspective, the grade plan expresses a budgetary constraint on the extent to which manpower requirements are met. It also shows typical supervisory ratios (as the ratio of members in one grade to those in another). By overlaying the year of service dimension, the grade profile depicts, if somewhat indirectly, the typical or average enlisted member's career pattern. The grade profiles for two successive years, coupled with knowledge of the loss rates by grade and YOS for the intervening year, provide a complete aggregate description of promotions during that year: select rates, phase points, promotion opportunities, etc.

6.1. EXISTING SYSTEM FOR GENERATING GRADE PROFILES

6.1.1. The Steady-State Objective Force Structure

DoD Instruction 1300.14 requires each of the armed services to specify an optimum force structure "which most economically and effectively accomplishes the Service's mission and has the capability for orderly expansion or reduction." Although the Instruction says nothing about specifying a steady-state optimum, all the armed services have chosen their objective or target force as one that could be maintained continuously without modification, once it is attained. If the force were to be in such a steady-state configuration, then a single grade profile would apply to two years successively, and coupled with loss rates, it implies a promotion policy. Although the Air Force has chosen to apply this idea only to the career force (members with more than four years of service), in principle it could also be applied to the total active force.

An important feature of a steady-state force is that the promotion rates it implies are consistent with each other and with a total (or career) active force size that is neither increasing nor declining. If those promotion rates were to be instituted beginning in any year (along with the associated accession or career force entry rates), and loss rates remained constant, the existing inventory would eventually tend toward the steady-state grade profile that served as the source of the promotion rates. In short, a steady-state force is self-sustaining.

This single advantage of a steady-state force, which is more interesting in theory than in practice, is outweighed by at least these four arguments against its use:

1. The steady state is never actually achieved. Promotion and loss rates would have to remain constant for perhaps 10, 20, or more years before the existing inventory would begin to be molded into the desired steady-state force. Because actual changes in policies, end strengths, and loss rates occur much more rapidly than this, the steady-state objective force always remains in the distant future.
2. The management actions implied by the steady-state objective force are not appropriate and are not used. Although the inventory would eventually approach the objective steady-state force if the promotion rates implied by the steady-state force were carried out, in the near term momentary peculiarities in the inventory could cause a movement away from the objective steady-state force. Moreover, promotions for the coming year must be tied to the budgeted end strength and corresponding grade constraints; it is inappropriate to attempt to implement any other promotion plan, whatever meritorious properties it may have.
3. A steady-state objective force is unstable when force sizes change. The original plan for TOPCAP envisioned that the size of the career force would be stable, with changes in the size of the total force being accommodated by changes in the size of the first-term force. However, the force drawdowns in the

early 1970s caused frequent changes in the career force targets. The TOPCAP Executive Review Committee reported in 1979 that during the 1973-76 period "new force structures became obsolete before they could be developed." Again, in the present period of planned growth, the objective force has been increased twice in two years and future changes are a distinct possibility. Only during the late 1970s, when total force sizes remained fairly stable, did the idea of a steady-state career force prove to be practical.

4. <u>The concept of a steady-state force is not helpful when change is planned for the future</u>. During periods when end strengths are planned to increase or decrease, Air Staff personnel planners must engage in a trial-and-error method for selecting an objective force structure that will tend to move the inventory in the direction of the changes planned over the near time horizon. Current planning procedures do not permit input of the planned end strengths (or other data) for a sequence of coming years to derive a suitable steady-state objective force that matches the data.

6.1.2. The Career-Force Objective

A potential benefit of using a steady-state objective force is that the total objective career force size is described by a single number--the Air Force calls this number the Career Force Objective (CFO)--which does not change from year to year. Adoption of an agreed value for the CFO automatically triggers many management actions concerning grades, promotions, accessions, reenlistment goals, etc., gradually changing the inventory in ways that can be anticipated by computerized models. The simplicity of this approach, in which many actions can be driven by a single number, is an important advantage of the current system.

However, in practice, when changing from one objective force structure to another, the implied management actions would be too wrenching if the new CFO were adopted immediately. Instead, a transitional series of objective force sizes is adopted to convert gradually from the current objective force level to the desired new level. No conceptually grounded principles underlie the calculation of the transition plan,[1] and the intended advantage of having a constant CFO is lost whatever transition plan is developed. In fact, the notion of establishing a "steady-state" objective that will last only one year is a contradiction in terms.

Another peculiar feature of the CFO is that it is typically nowhere near the current inventory of enlisted members with YOS 5 and higher, nor do the planners typically intend that it will be in the next few years. For example, when the CFO was 202,800, the number of enlisted members with YOS > 4 was nearly 240,000, and a planned increase in the CFO to 240,000 would increase the inventory of enlisted members with YOS > 4 above the 240,000 level. Thus, the "Career Force Objective" is an imaginary number that is used for programming grades and other aspects of the force structure but has no meaningful empirical referent corresponding to its name.

6.1.3. Role of Grade Richness Formulas in Grade Planning

Congressional mandates and agreements over the years between the Air Force and OSD have produced various formulas for calculating the allowed count of enlisted grades from the end strength and possibly other information. For example, a recent version of the formula specified n(k), the number of enlisted members in grade E-k, in terms of end strength and CFO as follows:

$$
\begin{aligned}
n(9) &= .01 \times (\text{end strength}) \\
n(8) &= .02 \times (\text{end strength}) \\
n(7) &= .234 \times \text{CFO} - (n(8) + n(9)) \\
n(6) &= .258 \times \text{CFO} \\
n(5) &= .497 \times \text{CFO} \\
n(4) &= .652 \times (\text{end strength}) - (n(5) + n(6) + n(7) + n(8) + n(9))
\end{aligned}
$$

[1] Currently the transition plan is developed by setting a future time period (e.g., FY 88) at which the new career objective force size will be attained and linearly interpolating between the present CFO and the new value. This yields an intermediate CFO for each intervening year.

The first two equations are actually upper bounds established by Congress, but ordinarily the Air Force tries to meet these end strength constraints as equalities.

Typically, any such formulas will have one or more parameters, like CFO in the above equations, that determine the grade richness of the force structure. To illustrate this point, Table 6.1 presents two grade structures having end strength 525,000. The structure determined from the above equations with CFO = 260,000 has substantially more grades E-7, E-6, and E-5 than the one with CFO = 210,000, and it has many fewer E-4 grades. In fact, the structure having CFO = 260,000 may appear unachievable because the number of members in grade E-5 far exceeds the number in grade E-4.

However, either of these structures is feasible and "sustainable": by increasing the select rate from grade E-4 to grade E-5, the number of grade E-5 members can be made large compared with the number of grade E-4 members.

Table 6.1

TWO GRADE STRUCTURES HAVING END STRENGTH 525,000

	Career Force Objective			
	210,000		260,000	
	Size of Grade		Size of Grade	
Grade	Number	Percent	Number	Percent
E-9	5250	1.00	5250	1.00
E-8	10500	2.00	10500	2.00
E-7	33390	6.36	45090	8.59
E-6	54180	10.32	67080	12.78
E-5	104370	19.88	129220	24.61
E-4	134610	25.64	85160	16.22
E-1 to E-3	182700	34.80	182700	34.80

In the current enlisted force management system, personnel planners are not given much useful guidance in analyzing proposed grade richness formulas or in choosing values for any free parameters that may be in the formulas. An underlying principle of TOPCAP is that the manpower requirements for E-6 and above should "size" the force, but the E-6 to E-9 requirements are not necessarily attainable. If authorizations for grades E-6 to E-9 are used instead of requirements, the grade planning system is circular.[2] The personnel planners need more quantitative information about the implications of choosing among alternative grade richness formulas.

6.2. PROPOSED CONCEPT OF GRADE PLANNING IN EFMS

The proposed Grade Profile Generator incorporates without fundamental change the basic principles that have been used in the TOPCAP system for calculating the number of grades, but differs in three ways:

- It permits flexibility in the form of the formulas relating grade counts to end strengths.
- A series of interrelated annual grade plans is constructed, rather than a single steady-state force structure or separate grade plans for each year, and
- The Grade Profile Generator has as an objective, when choosing among alternative grade profiles, stabilization of enlisted force management parameters (e.g., select rates, phase points, and promotion zones).

In designing grade profiles, there is an inherent tension between three types of goals

- stable career progression,
- meeting mission requirements, and
- meeting budgetary limits.

[2] For example, ignoring minor influences such as the number of transients, if one aggregated the authorized grades on the 7102 file, one should produce the same grade totals as those previously determined by the personnel planners.

For example, if there were no budgetary limits or concern about enlisted members' career progression, the grade plan for each year could be established to meet manpower requirements exactly. The Air Force traditionally (and in the TOPCAP system) has placed high emphasis on stability of career progression. This is incorporated in the Grade Profile Generator by emphasizing constancy (or near-constancy) of promotion select rates.

This stability condition on select rates forces the grade plans for successive years to be interrelated. The Grade Profile Generator operates for a time horizon of Y years, which could be established in the design phase as five years or seven years but is best left flexible. For the first year or two of the Y years, the grade plan may have already been established (e.g., by earlier runs of the Grade Profile Generator). Because there is no difficulty in forcing the model's output for those years to agree with the previously decided input, we will not repeatedly mention this possibility in the descriptions that follow.

6.2.1. Formula for Grade Richness

The concept of the Career Force Objective is not included in the proposed design (although it is not specifically excluded, either). Instead, the Grade Profile Generator is designed under the assumption that the desired relationship between grade counts and end strengths has been specified by a collection of equations. (These may or may not have free parameters.) We will call these equations the formula for grade richness.

In incorporating this approach into the EFMS, we are providing continuity with the past while allowing considerable flexibility for the future: Any future formulas that express the grade counts in terms of end strengths and one or more parameters can be easily inserted in the Grade Profile Generator. The determination and negotiation of any future structural revisions are considered to be outside the framework of the EFMS.

6.2.2. Derivation of the Annual Grade Plans

Instead of calculating a steady-state objective force or an objective career force size, the new Enlisted Force Management System will provide alternative information that serves the purposes previously envisioned for the objective force. The output will permit giving enlisted members fairly accurate and understandable expectations of their future chances for promotion and will allow planners to understand how the inventory will evolve in the future.

To permit an enlisted member to anticipate his or her career path, the Grade Profile Generator incorporates algorithms that attempt to make promotion select rates fairly constant over the Y planning years. Although it will not (in general) be possible to sustain those select rates into the indefinite future, we expect that stability of select rates will be accomplished by the annual nature of the planning process. To illustrate, if a grade plan has been developed using estimated end strengths and required grades for fiscal years 1986, 87, 88, 89, and 90, then in the next year the plan would be developed for fiscal years 1987, 88, 89, 90, and 91. These differ primarily by the omission of 1986 and the addition of 1991; changes in the data for 1987, 88, 89, and 90 will be fairly small. Thus the second year's calculation is similar to the first year's, with about 80 percent of the data unchanged. For this reason it seems likely that the results will also not change dramatically. During the process of designing the details of the Grade Profile Generator, the Rand staff will assure that this stability is actually achieved.

How much leeway does the Grade Profile Generator have in choosing select rates? If the grade richness formula has no free parameters[3] and enlisted force end strengths are specified for each of Y years into the future, the aggregate grade plan will be calculated for each of these years directly from the formula. Four mechanisms are then available for molding the current inventory to match those grade plans:

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[3] Or, equivalently, the free parameters have been fixed for this run of the GPG.

- losses (including forced losses),
- NPS accessions,
- PS accessions, and
- promotions.

Supposing that the number of PS accessions has been decided and that no losses will be forced (for example, there will be no limits on entry into the career force), then NPS accessions can be calculated from end strength and predicted losses. Then the aggregate number of promotions out of each grade can be calculated directly from the grade plan, and the distribution of those promotions by YOS is determined by WAPS. In other words, under the stated assumptions there is only one feasible promotion plan for each year, and there is no leeway. (It may happen that no combination of NPS accessions and promotions can achieve the desired grade plan, in which case attaining the plan would require Air Force actions such as limiting career force entry or otherwise increasing losses, forcing demotions, or reducing the PS accessions. But more typically there will be exactly one solution.)

Because it does not appear sensible to limit grade plans to unique solutions that have no known optimality properties, we recommend three approaches for allowing room for alternative grade plans:

1. The grade richness formula could have one or more free parameters that can be permitted to vary from year to year.
2. The end strength constraints on the number of E9s and E8s could be taken as upper bounds rather than equalities.
3. The grade richness equations for n(k) could be taken as goals rather than equalities.

As mentioned earlier, for short time horizons (e.g., the operating and budget years) some or all of this flexibility will be impermissible, and the Grade Profile Generator will allow input of already decided values of the parameters or the n(k)s.

Promotion select rates depend not only on the time stream of grade plans but also on the losses that are forced at the end of the first term by the mechanism of career job reservations. Because the Grade Profile Generator will not specifically take reenlistments into account (but only the grade by YOS profile), the model will simulate this CJR mechanism by using career gates CG(4,y) and CG(6,y), which are the fraction of four-year and six-year enlistees who will not be permitted to continue past the original end of their first term in year y. These career gates represent losses above and beyond normal ETS/PETS losses and are equal to zero if all enlisted members who want to reenlist are permitted to do so. If the user desires, the GPG will permit the two career gates to be related to each other in accordance with predicted ETS/PETS loss rates for 4-year and 6-year enlistees.

Depending on the amount of flexibility allowed in calculating grade plans from end strength, the Grade Profile Generator will generate grade plans having either approximately constant select rates or exactly constant select rates. These are shown as Algorithm 1 and Algorithm 2 in Fig. 6.1. If the grade richness formula has no free parameters or if the n(k)s implied by the formula must be met exactly, it may not be possible to obtain constant select rates for Y years. In this case the following algorithm can be used:

> Algorithm 1. (Calculate approximately constant select rates.) Denote by s(k,y) the select rate from grade E-k in year y--s(k,y) is the fraction of eligible enlisted members of grade E-k who are promoted to grade E - (k + 1) in year y, k = 3, 4, 5, 6, 7, 8. The select rates can be calculated with or without the career-gate ineligibles in the denominator. The number of enlisted members in grade k in year y, which is a function of the end strength in year y and the free parameter(s), if any, for year y in the grade richness formula, is denoted n(k,y).
>
> Given the grade counts n(k) in year 0 (the starting inventory for the algorithm) and estimated end strengths for years y = 1, 2, ..., Y, the algorithm will choose values of the free parameters in the grade richness formula, if any, and the career gates CG(4,y)

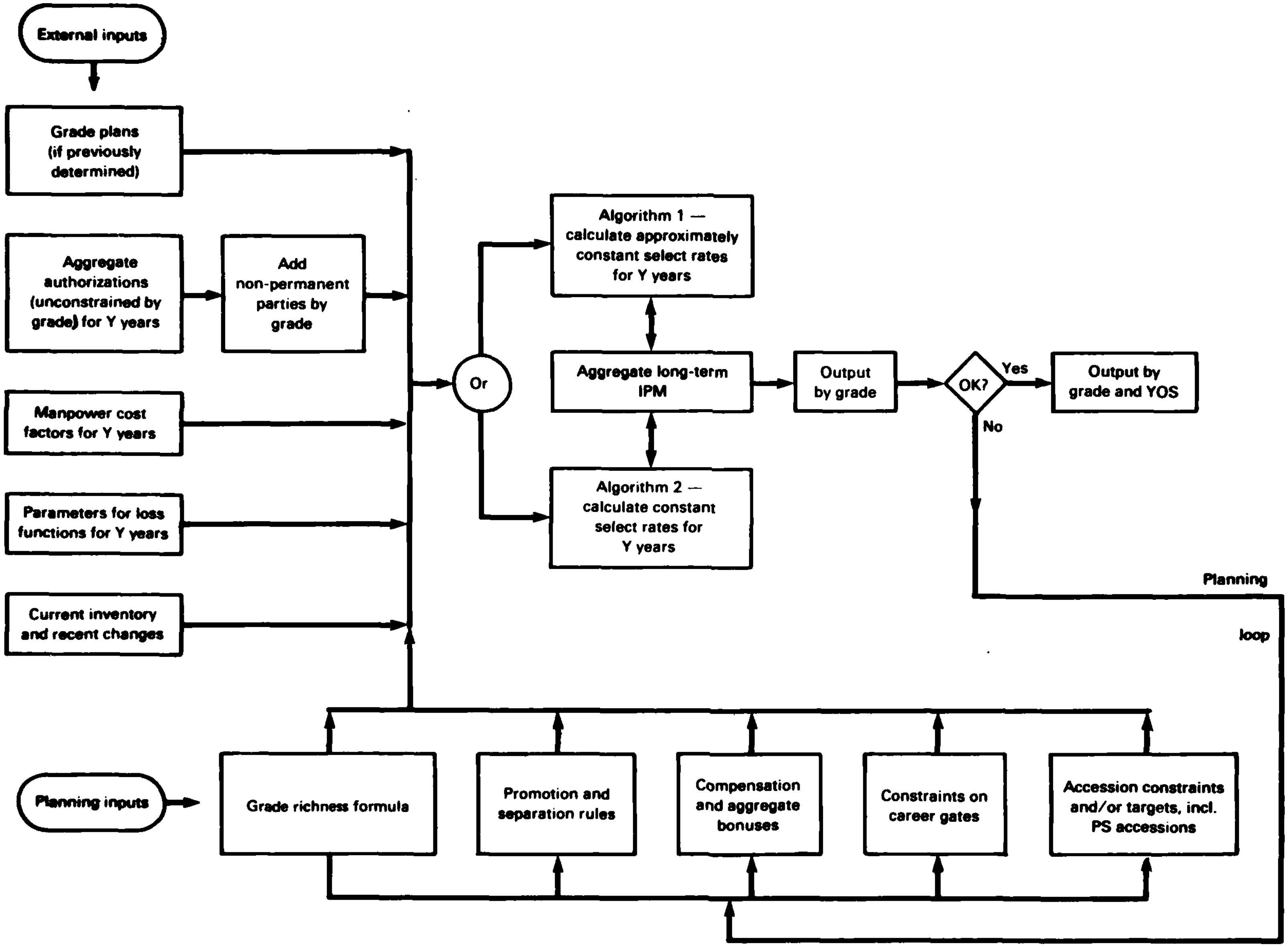

Fig. 6.1 — Flowchart for the calculation of annual aggregate grade plans in the Grade Profile Generator

and CG(6,y)[4] for years y = 1, 2, ..., Y to minimize a measure of the variance of the select rates over the planning horizon <u>and</u> a measure of the mismatch between the n(k,y)s and the counts of required grades in the authorizations. The budget constraint is expressed as a linear combination of the n(k,y)s, and the select rates can be constrained to fall within specified ranges or (equivalently) not to vary more than a specified amount from the current values.

The measure of variance for select rates could, for example, be

$$\sum_{y=1}^{Y} \sum_{k=3}^{8} w(k,y) \ (s(k,y) - \bar{s}(k))^2,$$

where

$$\bar{s}(k) = \sum_{y=1}^{Y} s(k,y)/Y.$$

and the numbers w(k,y) are weights (to be chosen later) allowing more or less emphasis on certain grades or certain years. (E.g., more distant years in the future could be considered to have less importance than upcoming years.)

[4] These are the decision variables in this algorithm. By user option, the career gates can be constrained. For example, they can be forced to be zero or they can be forced to be specified positive numbers. When career gates equal to zero are feasible but the user insists on positive values, the consequences are (a) higher select rates and (b) larger NPS accessions needed to achieve the same grade structure.

Choosing relative levels of importance for the two measures to be minimized is likely to be a controversial matter for this algorithm, yet it is fundamental because designing grade plans involves making trade-offs between requirements and promotions, subject to a budget constraint. The model simply makes explicit a policymaking process that is usually carried out more informally.

In Algorithm 2, more flexibility is allowed in achieving the grade plan (all three items listed above). Then the Grade Profile Generator will minimize the variance in select rates by making it zero, all the select rates will be constant over the time horizon. However, it will not necessarily achieve the n(k)s exactly, nor will it exactly meet the end strengths for E8s and E9s each year. Here is how it will work:

Algorithm 2. (Calculate constant select rates.) Let S(k) be the select rate from grade E-k, k = 3, 4, 5, 6, 7, 8. These six numbers, along with the free parameters in the grade richness formula, if any, and CG(4,y) and CG(6,y), y = 1, ..., Y, are the decision variables for this algorithm. The estimated end strengths for years 1, ..., Y are given. Let N(k,y) be the number of enlisted members in grade k in year y if the select rates are constant at S(k) over the time horizon. (These numbers are functions of the decision variables through inventory projection.) The objective function to be minimized is a combination of (1) the mismatch between the N(k,y)s and the n(k,y)s and (2) the mismatch between the N(k,y)s and the count of required grades in the authorizations. The number n(k,y) is the value of n(k) calculated from the grade richness formula using the value of the decision variable(s) for the free parameter(s).

The following end strength constraints are applied when the minimization is performed:

$$N(9,y) \leq n(9,y)$$
$$N(8,y) \leq n(8,y).$$

(These state that in each year E-9s cannot exceed 1 percent of end strength and E-8s cannot exceed 2 percent of end strength.) The constraints on budget and select rates are also applied as in Algorithm 1.

The measure of mismatch between the N(k,y)s and the n(k,y)s might have a form such as

$$\sum_{y=1}^{Y} \sum_{k=3}^{8} v(k,y)(1 - N(k,y)/n(k,y))^2,$$

where v(k,y) is a weight (to be chosen during design of the model). The weight v(k,y) indicates the amount of emphasis to be given to meeting the goal n(k,y) in year y. In analysis during the design phase the Rand staff, in consultation with Air Staff planners, will develop a weighting scheme that yields suitably stable solutions.[5]

To carry out the calculations for either of these models, assumptions must be made about various factors that are shown as external inputs or planning inputs in Figure 6.1. These include PS accessions, rules for promotion eligibility, and estimates of future compensation levels and economic conditions that are related to retention of enlisted members. The model will not recommend levels of PS accessions. However, the output will show the difference between the grade plan and required grades and, for Algorithm 2, the difference between N(k,y) and n(k,y), k = 3, ..., 9, y = 1, ..., Y. Any of these differences, especially for grades E-4 and E-5, can be considered indications of an aggregate need for higher PS accessions, and the user can change the input accordingly, if desired.

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[5] For example, the solutions should not change substantially if end strengths change slightly, nor should the solution change from year to year if the data don't change.

The Grade Profile Generator will include a feature, not apparent from the figure, to allow loss rates to vary with the promotion policy chosen. An iterative procedure will first calculate the grade plan based on loss rates derived from promotion select rates previously estimated by the model. Then it will change the loss rates to reflect the promotion policy just derived and repeat the calculation. The user will be able to omit this fine-tuning if that degree of accuracy is not desired.

6.3. DETERMINATION OF ANNUAL GRADE PROFILES

The grade profile is a count of enlisted members by grade and YOS. Given annual grade plans and the current inventory, the only calculation needed to produce annual grade profiles is to spread each grade's losses and promotions by YOS. In current models it is assumed that losses and promotions are spread by YOS in the same proportions as were experienced in the recent past (e.g., last fiscal year). In the new EFMS, losses will be estimated as described in Sec. 5, and promotions will be modeled so as to simulate the behavior of the actual promotion system used in the Air Force. The new EFMS will not only permit more accurate estimation of grade profiles under the existing promotion system but, in gaming mode, it will have the capability to explore changes in the promotion system, especially eligibility rules and the formula used to calculate an enlisted member's WAPS score.

The long-term aggregate IPM in the Grade Profile Generator makes its calculations by YOS even when determining the grade plan (which is aggregated across YOS). For example, the loss model breaks down losses into categories such as first-term reenlistment, which depend on YOS, and it distinguishes between four-year and six-year first term enlistees. Moreover, the career gates apply only to airmen at the end of their first term (YOS = 4 or YOS = 6).

During the design phase, the Rand staff plans to undertake comprehensive analyses of past promotion data to determine how the components of WAPS scores are distributed across YOS and TIG. The WAF-APDS data available from the Air Force Human Resources Laboratory will be merged with the EAGL data, to carry out this analysis. Relevant content of the WAF-APDS file is as shown in Table 6.2.

Table 6.2

DATA AVAILABLE ON WAF-APDS FILE FOR EACH ENLISTED MEMBER FOR EACH PROMOTION CYCLE
(Selected Items)

Control AFSC
Promotion eligibility status
Military decorations
Airman Performance Report (APR) evaluations (up to 12)
Promotion Fitness Exam (PFE) scores
Specialty Knowledge Test (SKT) scores
Time in Grade (TIG)
Time in Service (TIS)
Senior NCO board score
Total WAPS score
Cutoff WAPS score for this AFSC
Relative position for promotion in this AFSC

Although the data are for individual airmen, the simulation in the Grade Profile Generator will be not an entity simulation but an aggregate simulation. For each grade, the distribution of WAPS score (or alternative formula) by YOS will be estimated, a cutoff score will be imitated to correspond to the desired select rate, and the fraction of airmen in each YOS above the cutoff will be calculated. The promotion policy in effect in one year affects the residual (unpromoted) group of enlisted members who are eligible the next year, so the calculation will be repeated sequentially.

6.4. OPERATING THE GRADE PROFILE GENERATOR

When installed, the Grade Profile Generator will be embedded in an interactive computer program that will allow for rapid input and output on the screen. Although Rand will not be designing the complete package, including input and output routines,[6] we give here some suggestions for its construction. While these suggestions are stated in specific terms for the GPG, they apply more generally to all of the modules of the system. We propose that all permit similar types of

[6] Rand is preparing only the conceptual and mathematical design.

interactions with the user and that all have similar input/output capabilities.

The input and output of the Grade Profile Generator are summarized in the EFMS flowchart in the appendix, which also shows the relationship between the Grade Profile Generator and other modules in the EFMS. Two principles will guide design of the package's input and output:

1. Some input items will be discretionary with the user: They can be entered if the user is interested in exploring their effects, or they can be omitted. In the latter case the program will make a reasonable default assumption. For example, the grade plans will be affected by user input concerning expected future years' unemployment rates (because unemployment enters into the loss function); but the user will not have to enter unemployment rates in order to run the GPG.
2. The user will ordinarily be interested in two versions of the output and comparisons between the versions. For example, one version might be the grade plan calculated last year and the other the grade plan calculated this year; one might place no limits on career force entry and the other calculate "optimal" career force gates. Or the two might differ in their assumptions about future military compensation or the formula to be used for calculating WAPS scores. To facilitate these comparisons, the user should be permitted to provide headings for the two versions and to display them in side-by-side columns with differences shown in a third column.

The users of the GPG should be able to view aggregated information about the grade plan on the screen of their terminal. When they are satisfied with the grade plan, or if they want more detailed information, they should be able to request printed (hard copy) output. A menu should permit users to choose among the package's modes of operation, to update or modify input data, to activate or inactivate constraints, and to specify desired output. When entering new data, users should be able to recall previous input files and edit them on the screen.

6.4.1. Input for the Grade Profile Generator

The input data have been labeled in the flowcharts as either external inputs or planning inputs. There are no hard and fast separations between the two types of input, and the user will be permitted to change either type when running the Grade Profile Generator. However, the "planning inputs" will be changed during runs of the GPG specifically for the purpose of trying to improve or adjust the grade plan being generated by the model. The "external inputs" would be changed in response to changes elsewhere in the Air Force or in the civilian economy, or they will be changed to explore the sensitivity of the grade plans to unknown future variations in these external factors.

External Inputs

1. Aggregations by grade of authorizations that are unconstrained by grade

   These data must be provided for each of the Y years for which the model is to be operated (except when a previously determined grade plan is input for the year).[7] They may be obtained by summing the "required grades" column of the 7102 file, yielding a small number of data items that could possibly be manually input. However, even though it appears that the Grade Profile Generator makes no distinctions among skills (AFSCs), the loss module that feeds the aggregate long-term IPM in the GPG may require separation of the input for AFSC groupings. For this reason, and because projected authorized grades would be useful inputs, the GPG may benefit from a computer-readable interface with the Skill Projection Model (SPM).

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[7] A previously determined grade plan (the count of authorized grades) would typically be input for year 0 and possibly also for year 1 and year 2.

2. Manpower cost factors
   These are aggregate factors for breaking down military compensation (see planning input #3, below) roughly by grade and YOS. The Grade Profile Generator is not intended for budgeting purposes, and a need to keep track of numerous detailed cost factors would be a nuisance for its users. Therefore, the manpower cost factors in the model should be rough approximations suitable for use in the algorithms described in Sec. 6.2. Constraints on the manpower budget are also input.
3. Parameters for loss functions for each of Y years
   These include, in addition to military compensation, the expected mix of accessions by race, sex, and quality; expected civilian wages; anticipated unemployment rates; and the values of the coefficients of the loss models, which must be fitted to past data and updated from time to time. Most of these inputs will be provided by a computer-readable link to the loss module, but the user of the GPG can change them. For purposes of sensitivity analysis, the GPG user will be able to change specified loss rates upward or downward. (For example, increase ETS/PETS losses for first-term four-year enlistees by 5 percent.)
4. Current inventory and recent changes
   These data are aggregate counts of enlisted members by grade and YOS, within skill groups that may be needed for the loss module. The user can specify the number of months between the inventory and year 1 of the model's calculations.

Planning Inputs

1. Formula for calculating grades from end strength, etc.
   This is the grade richness formula for n(k) discussed in Sec. 6.2.1. (Two examples are given in the appendix.) The formula must have at least one free parameter for the algorithms in the Grade Profile Generator to have anything to do when calculating grade plans.

2. Promotion and separation rules and parameters
These are the conditions (e.g., time in current grade or TEMSD) required for promotion eligibility, the fraction of enlisted members in a grade, if any, to be promoted BTZ (below the zone), HYT (high year of tenure) rules, length of time before ETS that PETS separations are permitted, the formula used for calculating WAPS scores, and the distributions of WAPS scores (or any proposed modification)[*] by grade, TIG, and YOS.
3. Compensation and aggregate bonuses
These data are compensation levels that the user can manipulate in anticipation of possible future pay raises, changes in bonus or retirement policies, etc. They are used in projecting losses and in the algorithms described in Sec. 6.2.2.
4. Constraints on career gates
The user can force the career gates CG(4,y) and CG(6,y) to be zero (no restrictions on entry to the career force), can set upper or lower bounds on them, can force them to be related to each other in specified ways, or can let them be free parameters.
5. Accession constraints or targets, including PS accessions
Assumptions about PS accessions are needed to operate the grade planning algorithms. NPS accession targets are allowed as input for projecting output past Y years. For earlier years the relative proportions of four-year and six-year NPS enlistees can be specified.

6.4.2. Output from the Grade Profile Generator

The output from the Grade Profile Generator is summarized in the flowchart in the appendix. As mentioned earlier, the output should be available simultaneously for two versions of the input, with a mechanism for identifying and displaying differences between them. Users should be able to provide titles, headings, and other text that helps them

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[*] When the Grade Profile Generator is used to analyze proposed new formulations of WAPS scores, a preprocessor will require information on the distributions of the component scores to be used in calculating WAPS scores.

recall the distinctions between the two versions, and all hardcopy output should include summaries of the input data and assumptions underlying the calculation.

The following is a summary of user-oriented output from the Grade Profile Generator. In addition, the model will generate self-diagnostic information (e.g., iterations required for convergence of optimization algorithms) and computer-readable information needed by other modules in the EFMS. Output that is simply a pass-through of input data for comparison purposes (e.g., aggregate authorizations by grade compared with the grade plan) is not explicitly mentioned below.

1. Grade profiles

   Tables of enlisted members by grade and YOS for Y years into the future are the primary output from this module. Grade plans (counts of grades by FY without the YOS dimension) are also output from the module.

2. Deviations of grade profiles from authorizations; aggregate PS accession needs

   Mismatches between the model's calculated grades and the target grades (either from projected authorized grades, or from the input formula) in grades E-4 and E-5 can be considered aggregate PS accession needs. This interpretation is by user option.

3. Implied manpower costs

   The input compensation levels and manpower cost factors are applied to the grade profiles, and the result is compared with the input budget constraints.

4. Promotion plans by grade

   These include eligibility zones, select rates (by FY if not constant), ultimate promotion opportunity if the model's select rates were to be continued indefinitely, phase points by FY, distribution of promotion probability by YOS, and the number of enlisted members to be promoted each FY.

5. NPS accessions

   These are calculated for each fiscal year from the desired number of enlisted members with YOS = 1, by taking into account training losses and other early attrition. They are separated into four-year and six-year enlistees.

6. Number of career job reservations
The aggregate number of CJRs can be provided for each fiscal year. Initially the GPG calculates the number of four-year enlistees at YOS = 4 who are planned to reach YOS = 5 in the next year, and the number of six-year enlistees at YOS = 6 who are planned to reach YOS = 7. These numbers differ from career job reservations because some enlisted members extend without eventually reenlisting. A post-processor of the GPG can be invoked to convert career gates into CJRs.

7. Projections of inventory
If the user specifies accession levels or end strengths past Y years, the IPM will project the grade profiles any number of years in the future. The constant (or average) select rates calculated by the model will be used in this projection.

7. GRADE RESTRUCTURING

Grade restructuring is part of the process of determining an authorization's attributes. It produces an allocation of the grade counts in the grade plan among occupations and among MAJCOMs within occupations. The MAJCOMs use this allocation in setting the authorized grades for their funded positions. Personnel programmers then use the resulting set of authorizations aggregated to the level of specialty and grade as the target for their actions.

The grade restructuring process uses the specialty and required grade associated with each authorization to determine the grade allocation. Simple counts of the authorizations with each required grade cannot be used as the allocation because these generally do not meet the budget constraint reflected in the grade plan. In addition, counts of authorizations by required grade by specialty may be inconsistent with the constraints inherent in the personnel structure of the Air Force, such as the need for a visible and equitable promotion policy in each occupational specialty and the closed nature of the personnel system. The grade allocations by specialty that are produced by the grade restructuring process should consider these personnel and budget constraints as well as the nature of the workload within each occupation (e.g., labor intensive versus highly skilled technical work), which is reflected in the distribution of required grades.

This section considers how the EFMS might support the manpower and personnel community in this restructuring process. It describes the current Air Force approach to grade restructuring and points out the strengths and weakness of the principles and procedures used. It then describes how the EFMS might improve the process.

7.1. CURRENT RESTRUCTURING PROCEDURE

The current process starts with the set of authorizations unconstrained by grade and proceeds through the following four steps to allocate the grade plan:

1. The total number of grades available to be allocated (the "factorable grades") is calculated by taking the grade plan for the total enlisted force in a grade and subtracting "fixed grades" that must be allocated to that grade.
2. The available grades determined in step 1 are then divided among Career Progression Groups[1] (CPGs) so that each CPG gets its "fair share" of the total, in proportion to MAJCOM-validated requirements. The result is called CPG1.
3. The percentage distribution of grades from step 2 is then modified so that it is closer to the percentage distribution of factorable grades found in step 1. The purpose of this step is to decrease the amount of crosstraining necessary to fill the authorizations. Some crosstraining will frequently be needed to accommodate the labor intensity or technical nature of the CPG. (If a CPG happened to have the same grade mix as the overall force in step 1, no change would be needed in this step. The CPG would be assumed to be completely self-sustaining.) The result is called CPG2.
4. CPG2 is then allocated to each MAJCOM in proportion to their share of CPG1.

The result of step 4 is a recommended allocation of the factorable grades to each combination of CPG and MAJCOM. The MAJCOMs retain the final decision concerning how they wish their allotment of grades to be allocated among specialties, but they cannot exceed their total command allocation. We discuss each of these steps in more detail below. We will use the phrase "occupational structure" to denote any particular distribution of grades within an occupation.

[1] A grouping of occupational specialties based on the first three digits of the AFSC.

7.1.1 Fixed Grades

In step 1 of the grade restructuring process, fixed grades are subtracted from total funded grades. Categories of fixed grades include: (1) students and patients, (2) transients, (3) special occupational categories that do not provide for normal progression patterns (e.g., first sergeants, special duty identifiers, reporting identifiers, and the Air Force band) and, (4) fixed grades required by unusual mission requirements (these are requested by the MAJCOMs and approved by the Air Force Director of Manpower and Organization).

The result of this calculation is C_j = the number of positions that can be allocated grade j in all the remaining authorizations.[2]

7.1.2. Creation of CPG1

CPG1 is determined by a computer program that apportions C_j among the various CPGs. Let

R_{ij} = number of authorizations with CPG i and required grade j (excluding the fixed grades, if any)

C_j = funded ceiling on grade j after the fixed grades have been removed.

The result of the calculation will be

X_{ij} = number of CPG1 positions in CPG i allowed to have grade j.

For each CPG, the program begins at the highest skill level, determining a number of positions with grades E-8 and E-9 that is proportional to the requirements for skill level 9. That is:

[2] To make the process clear to the reader unfamiliar with Air Force nomenclature, we speak of the grade counts in CPG1 and CPG2 as if they were actual positions, although they have no external existence. The allocation of the number of authorizations is completely unaffected by the grade restructuring procedure.

$$X_{i8} + X_{i9} = (C_8 + C_9)\left[\frac{R_{i8} + R_{i9}}{\sum_n (R_{n8} + R_{n9})}\right] \tag{7.1}$$

Then the positions with skill level 9 are divided between grades E-8 and E-9 according to the ceiling percentages for the two grades. That is

$$X_{ij} = (X_{i8} + X_{i9})\left[\frac{C_j}{C_8 + C_9}\right]$$

$$= C_j\left[\frac{R_{i8} + R_{i9}}{\sum_n (R_{n8} + R_{n9})}\right] \qquad \text{for } j = 8 \text{ and } 9. \tag{7.2}$$

Skill levels 7 and 5 are then processed sequentially, with unfilled requirements at higher skills "rolled down" to the lower skills. For example, for skill level 7, the number of grades allowed is calculated as:

$$X_{i6} + X_{i7} = (C_6 + C_7)\left[\frac{R_{i6} + R_{i7} + R_{i8} + R_{i9} - X_{i8} - X_{i9}}{\sum_n (R_{n6} + R_{n7} + R_{n8} + R_{n9} - X_{n8} - X_{n9})}\right]. \tag{7.3}$$

The total positions within the skill are then divided among grades according to the ceiling proportions for the appropriate grades. For skill 7:

$$X_{ij} = (X_{i6} + X_{i7})\,\frac{C_j}{(C_6 + C_7)} \qquad \text{for } j = 6 \text{ and } 7\ . \tag{7.4}$$

Finally, the number of positions with grade E-3, X_{i3}, is calculated as the residual:

$$X_{i3} = R_{i3} + \sum_{j=4}^{9} (R_{ij} - X_{ij}) \tag{7.5}$$

Equation (7.5) ensures that the sum of the positions distributed in CPG1 is the same as the total authorizations.

The concept of "fair share" inherent in this step of the procedure is that, at each skill level, each CPG's share of the grades associated with that skill level is proportional to the sum of the requirements at that level and all unfilled requirements at higher levels. Thus, in determining the number of top-four grades in a CPG, more "weight" is put on the requirements for grades E-8 and E-9 than on the requirements for grades E-6 and E-7. For example, if two CPGs required the same percentage of top-four grades, the one of the two that required a greater percentage of top-two grades would get a slightly greater percentage of total top-four grades in addition to a greater percentage of top-two grades.

The ratio of positions allocated for the two grades within each skill is determined by the ratios of the grade plan:

$$\frac{X_{ij}}{X_{ij+1}} = \frac{C_j}{C_{j+1}} \qquad j = 4,\ 6,\ 8 \tag{7.6}$$

Because in this context the operational proxy for a "sustainable" grade structure is grades proportional to the Air-Force-wide average, the within-skill-level grade structure of the CPG is sustainable. However, the number of positions allocated to a skill level is calculated solely from the required grades on the authorizations, so the mix of skills within the CPG may not provide a sustainable structure. The next step addresses this problem.

7.1.3. Creation of CPG2

In this step, the grade structure in CPG1 is transformed into a structure (CPG2) that is more sustainable (if such a transformation is needed). The process relies on human judgment to choose among alternatives the one that achieves a sustainable structure above a selected grade without altering the CPG1 profile too much. Each CPG is treated separately. A CPG2 alternative is associated with each group of top X grades (X = 1 to 6). These six alternatives are called the "Top X models" and are generated as follows. Let D_j be the fraction of the grades that can be allocated to grade j. That is:

$$D_j = \frac{C_j}{\sum_m C_m}$$

For a particular CPG i whose CPG1 is given by X_{ij}, and a fixed "TOP X" model, say one based on the top k grades, denote the result of the CPG2 calculation by

Y_{ij} = number of CPG2 positions in CPG i allowed to have grade j.

The first number calculated is N, the number of positions that would be in the CPG if it had the same number of positions in the top k grades as are found in CPG1 and the grades were in a "sustainable" relationship. That is:

$$N = \sum_{j=10-k}^{9} X_{ij} \Big/ \sum_{j=10-k}^{9} D_j . \tag{7.7}$$

Then:

$$Y_{ij} = D_j N \qquad j = 4, 5 \ldots 9 \tag{7.8}$$

and

$$Y_{i3} = \sum_{j=3}^{9} X_{ij} - \sum_{j=4}^{9} Y_{ij} \tag{7.9}$$

Note that Eqs. (7.7) and (7.8) imply that the number of top k grades in CPG2 is the same as the number of top k grades in CPG1. Equation (7.9) ensures that the total number of positions for CPG i in CPG2 is the same as that in CPG1, which was previously constrained to equal the number of authorizations for the CPG.

Following construction of a particular CPG2 alternative, the result is compared with CPG1. If it deviates too much from CPG1, then other TOP X models will be used and evaluated. It may happen that none of the six TOP X models are judged to be appropriate for a particular CPG. In this case, other alternatives must be tried. For example, applying Eq. (7.8) to all of the top six grades may result in the allotment of more positions than are available to the CPG. In this case, Eq. (7.8) would be applied only to the top n grades for some n < 6, and the lower grades would be shaped judgmentally.

In cases where a CPG2 alternative is produced by applying the full TOP X model (all of Eqs. (7.7), (7.8), and (7.9) are used), the CPG2 is said to be in a "sustainable" relationship from grade E-4 on. If, as is likely to be the case, the number of E-3 positions calculated in Eq. (7.9) is too large or too small to sustain the number of E-4 positions, then reclassification at the E-4 level is assumed to occur. If we assume that the CPG has Air-Force-wide retention rates and promotion rates, then the reclassification needed to meet this target must actually occur at the entry point to E-4 or at the E-3 level. If Eq. (7.8) is used only for the top n grades (n < 6), then reclassification is assumed to occur at grades higher than E-4.

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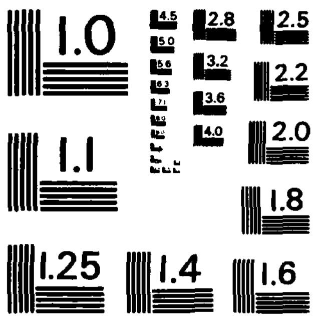

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7.1.4. Allocation to MAJCOMs

The grade allocation for the CPG is then divided among the MAJCOMs in proportion to requirements.

r_{ijk} = number of authorizations for CPG i and MAJCOM k, with required grade j, and

y_{ijk} = number of positions for MAJCOM k allocated to CPG i and grade j.

Then, when CPG2 is the chosen occupation structure:

$$y_{ijk} = Y_{ij} \frac{r_{ijk}}{\sum_m r_{ijm}}. \qquad (7.10)$$

When CPG1 is used it is allocated in the same proportions.

The values of y_{ijk} become the recommended grade allocations for each MAJCOM.[3] However, the MAJCOMs retain the right to set their own structures within their grade constraints; in some cases they may choose not to comply with the recommendations.

7.2. COMMENTS ON CURRENT PROCEDURE

Because the output from the restructuring procedure is so important to each operating agency--its allocation of grades--a guiding principle behind the procedure is that it be fair to each agency. This does not mean that each agency receives the same proportional distribution of grades; rather each agency receives a share of grades that takes into account differing mission requirements (as expressed by its "required grades"). In addition to being fair in fact, it is necessary that the procedure be perceived as being fair. Therefore, demonstrably equal treatment of each occupation was built into the current procedure.

[3] Each MAJCOM of course also receives the fixed grades that belong to it but were removed in the first step of the procedure.

An additional important attribute of the current system is that it is extremely flexible. Because the grade restructuring process must resolve the conflicting demands of different operating agencies, it is unlikely that any computational formula will result in the best answer in every future situation. Thus it will always be desirable to be able to bring human judgment and expertise to bear in allocating the grades. Information on the costs associated with alternative sets of structures (discussed below) should improve the decisionmaking process.

CPG1 represents the best fit to mission-based requirements that is possible within grade constraints. The TOPCAP distribution of grades suggests a CPG structure that can be realized by actions that are allowable under existing personnel policy (e.g., equal selection opportunity) and that provides for the maximum growth in experience within the occupation (because it can be sustained without any reclassification). If chosen, CPG2 represents an acceptable compromise between these two extremes. It is usually selected from among the TOP X models, each of which represents reclassification into or out of a different grade level. In selecting the most appropriate TOP X model, the fit to requirements is traded off against both the amount of reclassification that needs to occur to meet the grade structures and the resulting turbulence in the personnel system.

In the creation of CPG2 the major tradeoff is between the amount of reclassification and the fit to requirements. The current manual system does not provide information about the amount of reclassification required to produce an inventory that matches the occupational structure or the length of time that a typical enlisted member of each grade will have spent within the specialty learning his or her skill. However, it should be possible for a computer model to estimate the amount of retraining and the resulting experience levels implied by any structure.

The representation of personnel constraints used to create CPG2 could also be improved. For example, designated feeder/lateral relationships are not explicitly considered in the creation of CPG2. Consequently, feeder authorizations in the lower grades may not be adequate to sustain both their own and their laterals' requirements for higher grades. A computerized model could consider these feeder/lateral relationships among occupational specialties as well as those within a CPG.[4]

Constraints on the timing of retraining are not considered in the creation of CPG2. These constraints suggest that the TOPCAP distribution of E-4s and E-5s is inappropriate as the target in any occupational family that needs considerable retraining either in or out at the E-4 level. For example, a lateral specialty that receives many newly trained E-4s will have a higher ratio of E-5s to E-4s than the TOPCAP average. The reason for this is that the ratio of E-5s to E-4s in the career force is much higher than the Air-Force-wide average and retrained E-4s must either be in the career force or subsequently enter the career force.

Finally, the current procedure does not take into account the current two-tier promotion system or differences among specialties in loss rates. Because personnel programmers can control loss rates through the use of bonuses and tiered promotions, many grade distributions could be self-sustaining.

7.3. CONCEPTUAL DESIGN

The grade restructuring module in the EFMS will support the basic decision structure of the current restructuring process[5] but will provide a more formal treatment of flows among occupational specialties. The Air Force has developed reasonable procedures for determining fixed grades (step 1) and fair shares (step 2), and we see no reason to change either. However, we showed above that the simplified representation of retraining used in the creation of CPG2 (step 3) may lead to infeasible targets for the personnel system. The new module will therefore be designed to improve the creation of CPG2. An overview of the proposed grade restructuring subsystem of the EFMS is shown in Fig. 7.1.

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[4] MPM has informed us that specifications have been written to add this capability to the current system.

[5] Theoretically, an alternative would be to allocate grades to maximize mission capability subject to the personnel budget constraint and other personnel constraints. However, this is not an operationally useful concept with the present state of knowledge (e.g., productivity functions are unknown).

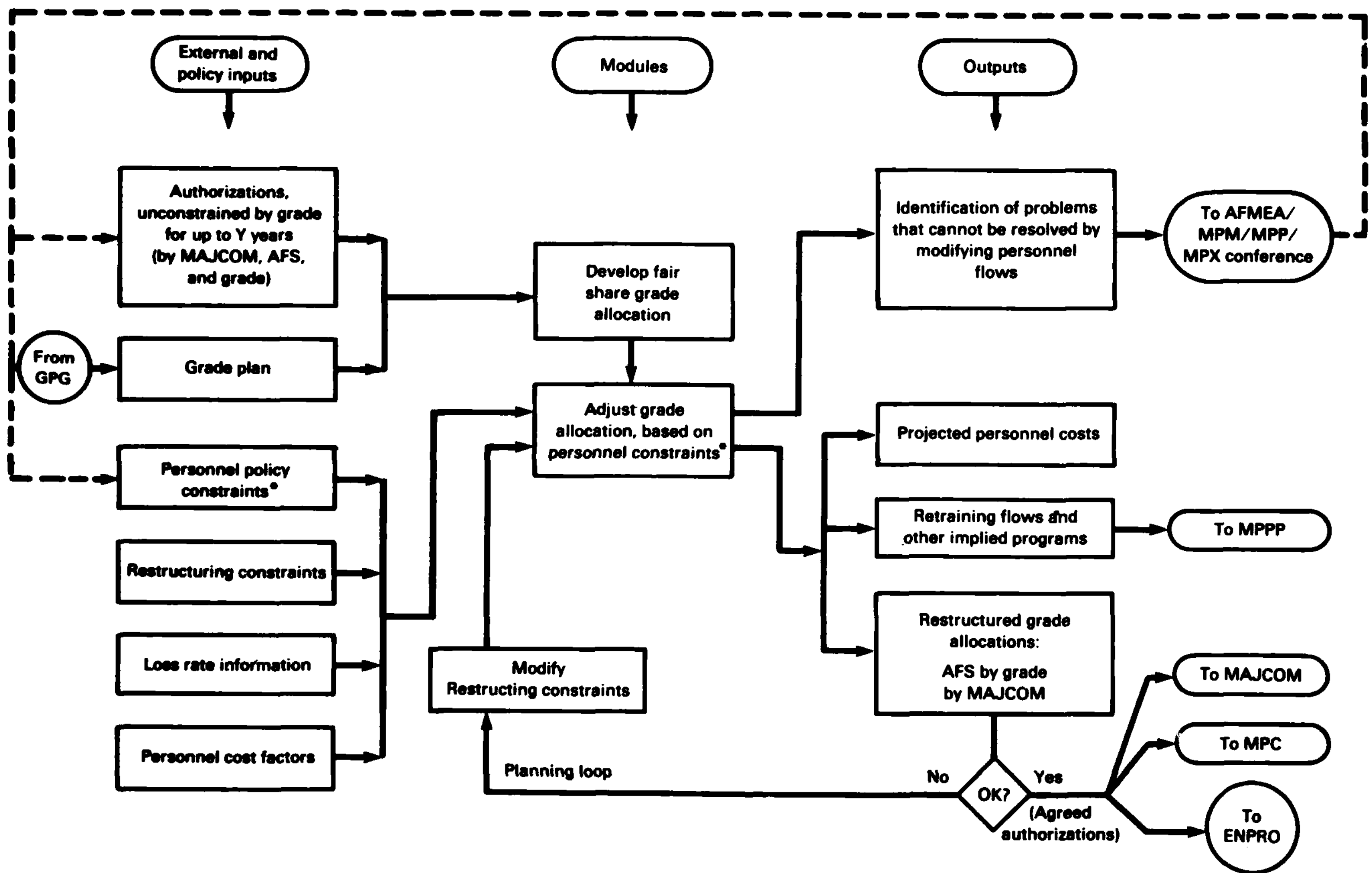

Fig. 7.1 — Flowchart of the grade restructuring modules

*Promotion policies, projected loss rates, and retraining policies

The new model will aid the current grade restructuring process, not replace it. Thus the decision process will retain the attributes of fairness[6] and flexibility that are present in the current system. It will aid users in determining targets for personnel programmers[7] that provide a reasonably close match to mission requirements (expressed in terms of each specialty's fair share of grades) and do not require too much reclassification to meet. The model optimizes the fit to requirements subject to constraints on promotions, losses, and the amount and kind of reclassification that can occur. By relaxing (or tightening) the constraints, the user can observe the improvement (or degradation) in the fit to requirements and the resulting decrease (or increase) in the length of time a typical enlisted person in each grade would spend in his or her specialty.

The purpose of the GRM is to suggest a set of targets by grade and occupational specialty that provides a good fit to the fair share of grades within each specialty and that is feasible. We define a grade structure to be feasible if acceptable personnel actions can create an ideal force that matches this structure.

Use of an ideal force means that the tradeoffs between reclassifications and fit to requirements that are observed in the model will not be a completely accurate representation of the potential tradeoffs in the real world. To get a more realistic representation of those tradeoffs, the model would have to use data on the current inventory. However, the existing inventory contains within it the results of many past personnel policy decisions; it seems inappropriate to constrain the <u>target</u> of the personnel system by the (possibly poor) decisions that the same system made in the past (although, of course, <u>actual</u> <u>production</u> will be so constrained temporarily).

The grade restructuring model could be either steady-state or dynamic. A steady-state model is conceptually simpler, involves the least change from current procedures, and allows one to restructure the grades one year at a time. (The steady-state assumption is used in the

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[6] We will discuss the concept of equal treatment of CPGs later in this section.

[7] The targets are labeled "agreed authorizations" in Fig. 7.1.

current procedure for creation of CPG2.) A dynamic model would provide a more realistic representation of the force. In a dynamic model, the ideal force would grow or shrink to meet projected authorizations, the grade composition would change to meet planned changes in the grade profile, and the occupational structure of the force would change as new weapon systems were introduced and old weapon systems were eliminated.

The model (whether steady-state or dynamic) will be basically a transportation model in which the flows consist of gains, promotions, losses, and reclassifications. The initial conditions and these flows define the force and therefore the resulting structures to be suggested by the model. The model will search for the set of policy-controllable flows that provide structures with the "best fit" to the fair share of grade allocations within a given set of constraints.[8] In addition to reclassification flows, other policy variables, such as first-term reenlistment rates and promotion tiers, could be decision variables in the model. (See the discussion of loss and promotion rates that differ by occupation later in this section.)

There are two major kinds of reclassification flows:[9] (1) flows designated in Air Force Regulation 39-1 (Airman Classification Regulation) that go from one named specialty to another named specialty and (2) flows that provide grade levels more in keeping with requirements than separate self-sustaining occupational specialties would allow. Flows of the first kind balance the fit to requirements given to feeder specialties with that given to lateral specialties. Flows of the second kind will be separately constrained so that one can trade the magnitude of these flows against the fit to requirements.

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[8] The requirements target could be taken directly from the current program that creates CPG1. However, since CPG1 is treated as an objective to be reached, it might be desirable to eliminate the current constraint that grades within skills be "sustainable." One could replace Eq. (7.6) with an allocation of grades that is proportional to the requirements for the grades within the skill level. It might also be desirable to obtain fair share of grades for smaller groupings of occupations.

[9] Section 8.3.3. mentions three additional reclassification flows: those due to disqualification in an AFSC, change in control AFSC, and CONUS-imbalanced specialties. The magnitude of these flows is very small compared with the two major flows discussed here. In the model, the other reclassification flows could be treated as uncontrollable background flows.

If there were no constraints on reclassification flows, this model would produce grade distributions that are very similar to those of CPG1. Constraints on the magnitude of the reclassification flows will produce a more manageable target force. Allowed constraints in the model will be as follows:

1. Laterals can be constrained to receive flows only from designated feeder specialties.
2. One can prohibit flows in some specialties at some grades (e.g., some specialties might be self-sustaining from grade E-6 on).
3. The direction of flows can be made consistent for some specialties. (If this is done, training into the specialty at one grade and training out of it at another would not be allowed in the model.)
4. Constraints on the timing of reclassification could be observed (these would probably relate solely to the first term force of E-4s and E-5s).
5. The total annual amount of reclassification into any specialty could be limited (perhaps stated as a percentage of all spaces within a specified grade range).
6. The total amount of reclassification in the entire force could be limited.

By varying these constraints (particularly the last two) the user could observe (1) the nature of the tradeoff between the fit to requirements and the amount of retraining, and (2) the effect of this retraining on experience levels.

This model can easily handle retraining out at more than one grade. Thus, the range of acceptable solutions has been expanded greatly from the range of solutions available from the "TOP X" models. We therefore expect that this model will enable one to choose a solution that provides a better fit to requirements than can be generated manually. If in any one case the output of the model does not provide a satisfactory fit to requirements, the binding constraint can be located and the reason for the lack of fit understood. In some cases the problem may lie with the structure of the work activity in the specialty, in others a problem with personnel policies may be identified.

The output from the GRM will demonstrate how close one can get to the required grades in each specialty by feasible personnel policies. However, this may not be close enough to meet mission requirements. Then, the EFMS will alert users to a mismatch between the required grades for a specialty and the input personnel policy constraints. The resolution of the problem must take place outside the system. For example, it might be necessary for the personnel programmers to modify their rule of thumb that limits the number of NCO retrainees that can enter a specialty each year. As another example, the structure of requirements in a particular specialty might be both top heavy and require that the senior personnel have extensive experience within the same specialty. This kind of situation can be remedied only by changing the structure of work in the specialty so that there are more positions in which junior personnel can obtain the experience necessary for filling the senior positions. Although it would take some time, the work structure could be modified and manpower standards and requirements updated to give the specialty a more attainable structure. These two examples illustrate the kinds of external planning processes that are represented by the dashed line in Fig. 7.1.

It is undesirable for the model to be constrained to match the historical loss and promotion rates for each specialty, because personnel programmers can affect these rates through the use of bonuses and a tiered promotion policy. However, the model could contain decision variables that reflect the actual degree of control of programmers over these rates. For example, it might be possible to get a better fit to requirements by allowing first term reenlistment rates to vary by specialty within limits imposed by the responses of airmen to bonuses. Promotion flows in the two-tiered promotion system might also produce a better fit to requirements than would be produced using average promotion flows.

In addition, because much of the variance across specialties in loss rates is due to factors outside the programmers' control, a model that took into account the real loss constraints in each specialty would more accurately portray the feasible tradeoff between fit to requirements and retraining. For the system to obtain this better fit and greater accuracy, it would have to sacrifice the advantages that accrue from treating all CPGs alike.

We do not now know how important the use of occupation-specific promotion and loss rates will be. It may be that their effects are so small compared with reclassification flows that they can be entirely ignored by this model. Exploratory analysis will address the sensitivity of the suggested structures to the use of occupation-specific promotion and loss rates. If the suggested structures are not very sensitive to expected variations in these rates, then we would recommend that average rates be used in order to maintain the concept of equal treatment of each occupation. Only if we can demonstrate a considerable improvement in either accuracy or fit to requirements would we recommend using occupation-specific promotion or loss rates.

The output of the grade restructuring module will be a suggested allocation of the grade plan by specialty, the reclassification and retraining flows required to sustain these structures, and the experience levels within the specialty that would result from the reclassification flows. The allocation of the grade structures to the MAJCOMs will also be calculated. In order to facilitate reaching agreement on a final set of structures, the module will also be capable of accepting any subset of authorizations as final and then calculating the allocations that would cover the remaining authorizations and the reclassification flows that would result. This capability could be used to explore the effect of MAJCOM revisions and to adjust the entire set of structures to account for the revisions that are accepted. The final output of the entire process will be a set of authorizations by grade and specialty that are agreed to by all parties and that become targets for the personnel programming portion of the system, which is described in Sec. 8.

8. MODULES FOR PROGRAMMERS

8.1. PURPOSE

The objective of the Force Programs Division of the Personnel Programs Directorate (MPPP) is to produce an inventory that matches the authorization target in each occupational specialty while remaining within constraints imposed by the budget and by personnel policies. The planners and programmers have many policy levers available for moving the force toward its target, including bonuses, training, and modifying separation and promotion policies. The operating year, budget year, and first planning year are most important to personnel programmers, but preliminary programs covering the entire FYDP are necessary in some instances.

The purpose of the programming modules of the EFMS is to provide MPPP with the information necessary for rational decisions on how and when to apply each of the programming policies. The necessary information includes the effects each program will have on the inventory, the costs associated with the programs, and the resulting manpower costs.

In the next subsection, we briefly discuss each of the policy decisions to be supported by the EFMS and the constraints under which the decision system operates. We then provide an overview of all the EFMS modules for programmers, discuss how individual decisions could be supported, and how tradeoffs among policy mixes could be evaluated.

8.1.1. Policy Options

A rich set of programming policies are available to help mold the force:

1. Bonuses may be offered to members of selected specialties to encourage retention of skilled personnel. Bonuses may also be offered to qualified persons willing to enlist to serve in selected specialties.

2. Airmen entering the force (NPS accessions) can be assigned to occupational specialties in order to arrive at the desired balance among specialties. This policy is implemented in two ways. Quotas are assigned to each specialty and available to recruiters through the PROMIS system. A qualified recruit can then choose a specialty from among the available spaces. Other airmen enter the force without having been promised a particular specialty and are assigned to specialties for which they are qualified and for which there is a need during basic training.
3. Persons already trained by the military who have left the service can be enlisted to help meet the need for experienced personnel (PS accessions).
4. First-term reenlistment is controlled by occupation through the Career Airman Reenlistment Reservation System (CAREERS). Quotas are set in each specialty. A first term enlisted person who wishes to reenlist must obtain a career job reservation against the quota. If the quota in that specialty has been exhausted, the enlisted member is provided with a list of other specialties where there are openings and for which the person is qualified. If the person agrees to retrain, then a career job reservation in the new specialty is provided.
5. Retraining among specialties is also used to balance the mix of more senior personnel. Lateral specialties require experience in feeder skills prior to entry, and a continual flow into laterals must be managed.[1] Under the PALACE BALANCE program, senior NCOs (grades E-5 to E-7) in overage specialties are retrained into specialties where they are needed. So-called CONUS-imbalanced specialties have too many overseas positions relative to CONUS positions to provide adequate rotation opportunities in the CONUS. Persons with such specialties must be trained into a specialty useful in the CONUS for tours here

[1] Many, but not all, laterals are fed at the first-term reenlistment point, and therefore the career job reservation system is also an important means of managing lateral flow.

and then reclassified into their overseas specialty to serve overseas again.

6. In order to increase retention in shortage specialties, a three-year program with a two-tiered promotion system is in progress. Before the two-tiered promotion system, the proportion of eligibles who were promoted during each cycle was the same in each specialty. Under the two-tiered system identified shortage specialties can receive a selection rate five percentage points higher than nonshortage specialties.
7. The high year of tenure (HYT) is the maximum number of years that a person with a particular grade may serve in the active force. Persons who reach the HYT without having been promoted to a more advanced grade must separate. Although the HYT for each grade is rarely changed, personnel programmers frequently allow waivers of HYT in order to maintain manning levels in particular shortage specialties.
8. Promotions are scheduled throughout the year in order to stay within budget constraints during the operating year, and a promotion schedule is developed to estimate budgets for future years.
9. Personnel can be released from their enlistment contract earlier than their scheduled expiration of term of service (ETS). One early release program, PALACE CHASE, provides for the buildup of the reserves by allowing enlisted persons to trade a period of active service for a longer period of reserve service. During the force drawdown of the 1970s and in response to the high retention rates of FY82 and FY83, early release programs were used to reduce the force to meet end strength limitations.

These decisions are highly interrelated. For example, one can increase the number of skilled personnel who will be in a specialty a year from now by increasing the number of personnel to be trained now, by increasing the reenlistment bonus, or by obtaining PS accessions. One can decrease the number of persons by reducing the rate of input to the specialty, by lowering the career job reservation quota, or by special loss programs.

8.1.2. Constraints

Despite the variety of policies available, the choice of the set of desirable policies is seriously constrained by a combination of factors. We have already noted the first of these constraints above: End strength and budget constraints affect the quantity and timing of promotions, accessions, and separations.

The supply of personnel is also constrained. Those who join and reenlist in the Air Force are volunteers who choose the Air Force rather than alternative sources of employment and careers. Their decisions are influenced by factors in the civilian economy such as wage rates and employment opportunities. The pool of eligible enlistees has been declining in recent years because of declining birth rates. This further constrains the supply of personnel.

Air Force personnel policy emphasizes the importance of the individual airman, and therefore programming policies try to be conducive to high morale. This places severe constraints on methods that can be used to match personnel to authorized positions. For example, transfers among specialties are determined in a way that maximizes the number of such transfers that are made voluntarily.

Many of the jobs performed by enlisted personnel require skills that can be learned only through extensive experience or training and frequently require both. Thus, it is not possible to mold the force instantaneously to meet current needs. Rather, the needed personnel must be "grown" over time as they learn occupational skills. Much of the learning occurs on the job and therefore requires the time and attention of those already skilled. In order to avoid overloading an occupation with trainees, MPPP has evolved a rule of thumb that restricts the number of persons retrained into a specialty each year to be less than 5 percent of the E-4 through E-7 authorizations in the specialty.

Implementation of some programs requires long lead times. Because Congress approves the total amount of selective reenlistment bonuses (SRBs) that may be awarded, the Air Force must request SRB funds in advance. This amount is initially determined during preparation of the POM. The SRB schedule for FY 84 was first set by May 1, 1982, when the end of the FY was 29 months in the future.[2] A lead time of 18 months is more typical. For example, decisions about training during a fiscal year are usually finalized in March of the preceding year, so that ATC can acquire and schedule instructors and other resources.

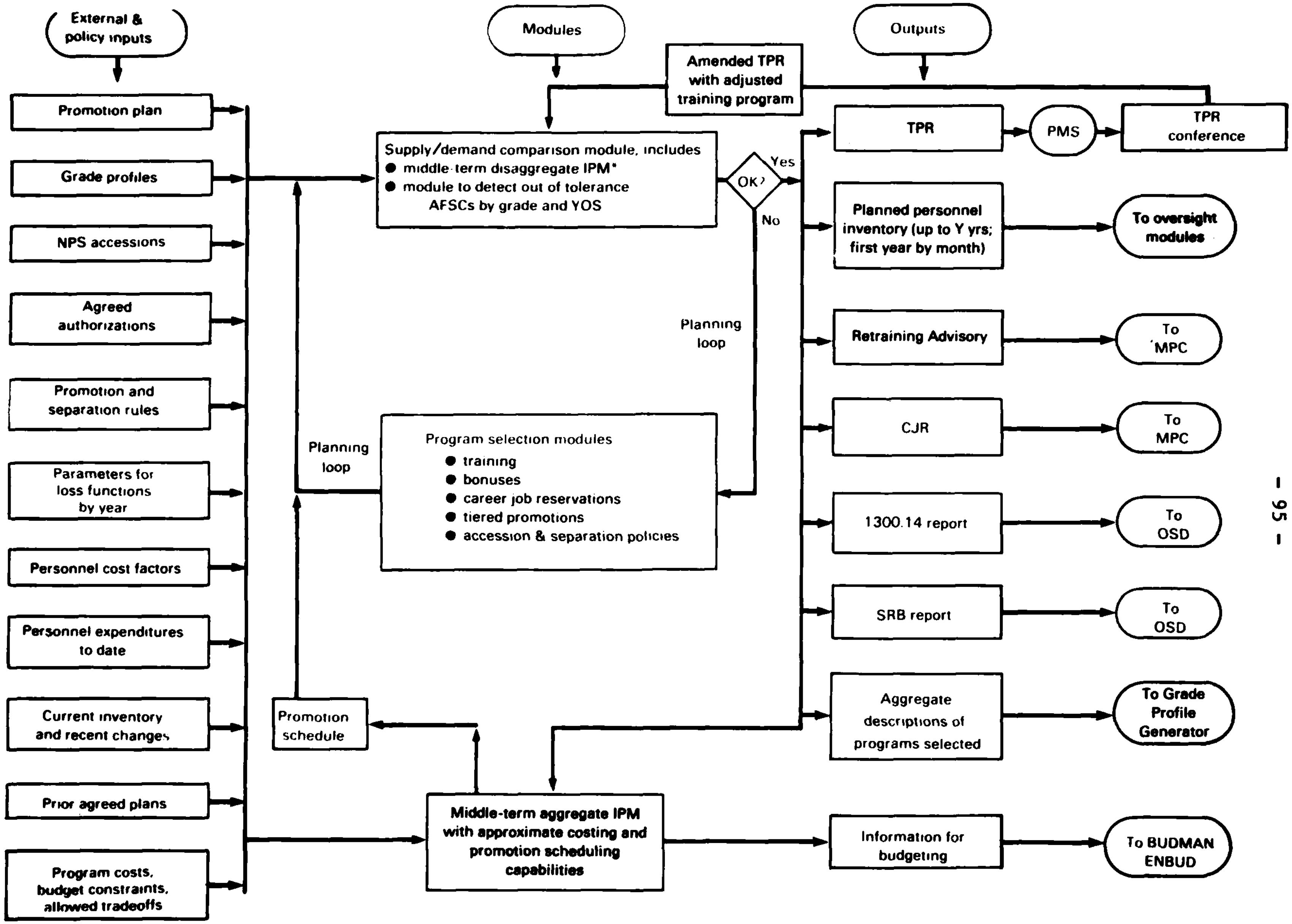
Despite the long lead times necessary for an orderly scheduling of resources, changes are continually being made in the target force in response to program element decisions during the PPBS cycle or by the Congress. Thus, personnel programmers are faced both with the necessity for planning over a three year or longer horizon and for continually modifying those plans to come as close as possible to hitting a continually moving target in the short run.

8.2. OVERVIEW OF PROGRAMMING MODULES

At the heart of the EFMS subsystem for programmers is an inventory projection module that estimates the future state of the inventory under given policy assumptions. Tied to the inventory projection module are a series of additional modules that suggest appropriate levels of each program. The user can constrain the policy selection modules to generate policies within stated bounds, or can bypass any or all of the policy selection modules by specifying policy decisions.

A flowchart providing an overview of this subsystem (named ENPRO, for Enlisted Programming System, by MPPR) is given in Fig. 8.1. ENPRO contains both an aggregate and disaggregate inventory projection module. The aggregate inventory projection module will be used primarily to estimate the budget and to schedule promotions. The disaggregate inventory projection module will be used for determining all occupation-specific programs. These two modules will play roles similar to the roles AFPAL and ASKIF play in the current system. The advantages of ENPRO over the current system include: (1) a much better loss prediction function that ties losses directly to policy decisions and economic conditions; (2) the addition of program selection modules that will improve decisionmaking and document the rationale for decisions;

[2] Adjustments in the allocation of SRBs among specialties can be made during the budget year or even the operating year. It is also not impossible to request a supplemental budget authorization from Congress.



*Optionally, this can be forced to be compatible with aggregate IPMs

Fig. 8.1 — Flowchart of the Enlisted Programming subsystem (ENPRO)

(3) the provision of a detailed projection of the planned inventory by occupation so that policy effects can be monitored and evaluated (see Sec. 9); and (4) the elimination of the time delays and manual processing steps that make operations in the current system so cumbersome.

8.2.1. Inventory Projection and Loss Models

The inventory projection modules derive their power from a loss function. Our general approach to loss modeling was described in Sec. 5. Here we mention only three features of the loss models that are particularly relevant to the conceptual design of the EFMS modules for programmers: (1) the treatment of early release programs, (2) the relationship between the loss predictions of the aggregate and disaggregate IPMs, and (3) the treatment of AFSC conversions.

In general, the predictions from the loss models will be based on expected economic conditions and decisions with regard to Air Force policy such as promotions and bonuses. The loss models will be based on historical data that describe how loss rates varied in response to economic conditions and policy changes, and thus will be able to predict how future circumstances and policy changes will affect the inventory. However, losses associated with early release programs are not as susceptible to historical analysis as those associated with other policies because they are controlled more by the decisions of personnel managers than by the decisions of airmen. When one decides to implement an early release program, one can also decide on the number of persons to release. Consequently, the loss functions that underlie the loss models will probably be designed to predict how many losses would occur at each point in the absence of any early release program. Early release programs would then be treated as changes in the timing of losses that are strictly under policy control.

Predictions from the aggregate IPM will not necessarily match predictions from the disaggregate IPM. However, it is necessary that results from policy decision runs (as opposed to policy analysis runs) of the two modules agree. In the current system, the disaggregate module's loss predictions are forced to match predictions from the aggregate module. This agrees with the order in which decisions are currently made, and with the necessity to occasionally provide quick response to policy problems. Consequently, we are proposing that the disaggregate loss model have the capability to take the total losses and promotions estimated by the aggregate module and distribute them among AFSCs.

Because the disaggregate loss model contains more detailed information, we expect its predictions to be more accurate than those of the aggregate model. Consider for example, the treatment of bonuses in the two models. Information on exactly which groups of airmen are offered which bonus levels is available to the disaggregate model, while the aggregate model knows only that some fraction of a larger group of airmen are being offered bonuses at different levels. The better information should improve the disaggregate model's predictions.[3] The extent of the improvement in prediction can be ascertained only through empirical analyses. If the improvement in prediction is substantial, we would recommend that the EFMS be able to constrain the losses in the aggregate model to match those predicted by the disaggregate model, and that this be the normal sequence of operations. The alternative mode would remain available in any case.

The level of detail of the reports from the IPMs for programmers will match the level of detail required for the particular analytical purposes of the run. For the disaggregate IPM this level of detail includes the number of airmen in each AFSC, grade, and (usually) year of service at the end of time periods specified by the user, and all flows (promotions, losses, gains) that occurred during each time period. For example, the time period relevant to bonus policy is six months long; the Career Job Reservations are fixed for quarterly intervals; and the training plan is usually analyzed on a fiscal year basis. The aggregate IPM will provide data on the total number of airmen in each month of the time horizon described at the level of detail needed to estimate and

[3] One might argue the opposite, because the aggregate model will be used for scheduling promotions. However, we believe the the effect of the timing of promotions on loss rates should be negligible. Because lists of selectees are published, airmen know whether they are scheduled for promotion. Probably few airmen's career decisions are changed because of a change of a few months in their promotion date.

manage budgets and promotion flows (grade, number of dependents, year of service).

As discussed in Sec. 5, the level of detail of the internal projections of the IPM may exceed the level of detail needed for user analysis. The level of detail of the projections will be based on the need for technical accuracy in the projection. In addition, the disaggregate IPM in ENPRO will predict using a monthly time horizon. Monthly predictions are a convenient way to get a good picture of the inventory for any future point. In addition, monthly predictions are a necessary input to the modules for oversight and monitoring. To obtain monthly predictions, ENPRO will need more detailed data on the pipeline than is used by ASKIF (e.g., the scheduling of ATC courses and class sizes).

Improvements in weapon systems, other equipment, and management practices of the Air Force necessitate frequent changes in the tasks of airmen and corresponding changes in the AFSCs that designate collections of these tasks. The EFMS will have to be supplied with data on planned AFSC conversions. However, assuming that the EFMS has accurate loss rates for the current set of AFSCs, conversions pose no conceptual problem for the disaggregate IPM, only a practical problem. At the appropriate point in simulated time, the IPM would flow the appropriate percentage (perhaps 100 percent) of persons from one AFSC to a newly created AFSC and estimate future loss rates in the new AFSC from the average loss rate (or parameters of the loss function) of the AFSCs that contributed to the new AFSC (weighted by amount of flow). As experience with the new AFSC accumulates, the initial parameter estimates would, of course, be updated just as the parameters for all AFSCs are routinely updated.

Past AFSC conversion also introduce complications into the process of estimating occupational effects on loss rates from historical data. However, changing definitions of subcategories is not uncommon in time series analysis, and we will apply the best available statistical tools to avoid both producing unnecessarily large variances in the estimates of occupation effects and missing true distinctions among occupations.

8.2.2. Program Selection Modules

The disaggregate IPM aids decisionmaking by showing the effects of program decisions on costs and on the inventory. The program decisions whose effects are to be projected can be either those chosen by the user or those suggested by one or more of the program selection modules called from the inventory projection module. Both of these modes can be used in the same run. For example, one might input agreed decisions for the operating and budget years, and let the modules select programs for the planning year.

The program selection modules will suggest "good" policies to decisionmakers for their consideration. The sophistication of these modules will vary greatly. The simplest ones will merely calculate the number of airmen to be gained or lost based on the difference between the projected inventory and its target. Others will use optimization techniques to find efficient solutions to the problem of molding the inventory to its target. Our recommendations about which modules should be of which kind are based both on the availability of data needed for sophisticated analysis and on Air Force priorities. Our recommendations are described below (in Sec. 8.3). The modular structure of the EFMS will allow the simpler models to be replaced with more sophisticated models whenever they become available.

The optimization problem associated with molding the inventory to its target can be stated in either of two ways: (1) allocate a fixed budget so that the resulting inventory is as close as possible to the target, or (2) find the least cost method of bringing the inventory within a specified deviation from the target. Although the solutions to these two problems are highly related,[4] it will be convenient for the user to be able to select either formulation. The solution to the allocation problem is most relevant for the operating year. The least cost solution is likely to be most useful for the planning year.

The more program decisions that are considered simultaneously, the more efficient the solutions can be. However, there are data problems

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[4] Because the solutions to both statements are on the "efficiency frontier," the least cost method of attaining a specified deviation is also the best allocation of that total budget.

that limit our ability to consider some programs within an optimizing framework at the current time. In addition, there are practical problems associated with simultaneously optimizing over large numbers of policy variables. These problems will require reasonably extensive analysis to resolve. Consequently the initial operational version of the EFMS will contain only one program selection module that simultaneously considers more than one program. It will optimize among programs designed to increase the supply of experienced personnel. Additional simultaneous solution modules can be added later. (None of the services currently have computer aids that simultaneously optimize over more than one personnel program, although the Army's FORECAST system may have such a capability in the near future.)

Even if at some time in the future it becomes possible to consider tradeoffs among all the personnel programs simultaneously, it will still be necessary for the EFMS to provide analyses that cover only one personnel program, and hold all other programs constant. This capability is desirable for exploratory analysis and necessary to meet time and budget constraints. For example, at a time several months into the operating year, the ATC course schedule may be difficult or impossible to change, but it will still be possible to redistribute bonuses planned for the second half of the operating year among specialties. Therefore, the EFMS is designed so that each individual personnel program can be analyzed while holding all other programs at specified levels.

When one is considering programs one at a time, the question of the proper order of decisionmaking arises. We believe that the timing of decisions imposes constraints that will almost always result in circular decisionmaking. Plans are first set for the planning year, modified (usually more than once) when the planning year becomes the budget year, and often modified again during the operating year. For each of these modifications, decisions on any single program should be made based on the best estimate available of what other programs will be. Even when a planning year is examined for the first time, programs planned for the previous year impose constraints on the ability to plan a set of programs de novo. For example, it is personnel policy that SRBs for a particular specialty not be reduced more than two levels at a time.

8.2.3 System Outputs

The major output of ENPRO is the set of programming decisions made by the decisionmakers who use the system. To facilitate decisionmaking, the system will have the kind of user-friendly input and output capabilities that were discussed for the Grade Profile Generator in Sec. 6.

The specific documents and files that result from these programming decisions are summarized in Fig. 8.1. They include:

1. A Trained Personnel Requirements (TPR) document that may be amended during the subsequent TPR conference. This document lists the number of entrants to each specialty for three years, the source of these entrants, and whether the entrants will require formal training. The sources of the entrants define the plan for PS accessions, NPS accessions, and reclassification and retraining by gaining specialty.
2. A Retraining Advisory that is intended to stimulate voluntary retraining into needed specialties. It will list the numbers of currently enlisted persons that the Air Force wishes to enter each specialty by grade and YOS (or YOS group) and restrictions placed by the Air Force on voluntary retraining (e.g., airmen may not leave some shortage specialties).
3. Quotas for career job reservations by specialty and quarter of the year.
4. The Enlisted Personnel Management Plan currently specified by DoD Instruction 1300.14.
5. The planned SRB level for each specialty for each six-month period and the supporting documentation required by OSD.

In addition, ENPRO will provide the projected personnel inventory for use by MPC and by the EFMS modules for oversight and monitoring, and an aggregate description of the selected programs for use by the Grade Profile Generator.

8.3. DECISION AIDS FOR OCCUPATION-SPECIFIC PROGRAMS

Figure 8.2 provides slightly more detail about the operation of the part of ENPRO that is designed to facilitate analyses of programs related to staffing particular AFSCs. The user specifies the run by selecting data files containing plans that are to be simulated by the IPM, and by stating constraints on programs to be generated by one or more of the program selection modules. If the authorization data base has changed since the last system run, the YOS Target Generator will be called. In any case, the inventory projection model will proceed using the set of agreed policies or the policies suggested by the program selection modules based on the difference between the target and the inventory.

In this section we begin with a description of the YOS Target Generator. Then we describe how the EFMS could aid managers in charge of each of the individual decisions listed in Fig. 8.2. These decision aids each assume that the level of the other programs has been specified. If more than one program is to be analyzed at one time, the user will either use a program selection module that makes multiple decisions or specify the order of calls to the program selection modules and the assumptions that are to be made about programs for which the selection module has not yet been called (e.g., the programs will operate at the same level as in the previous year's projection). The last subsection discusses ways of examining tradeoffs among programs.

8.3.1. YOS Target Generator

The Target Generator in the EFMS will be used to add a year of service dimension to the input authorization targets, which are specified by AFSC and grade.[5] The year of service targets are needed to determine career job reservation quotas and to manage the SRB program. They could also be used to analyze and manage other year group programs.

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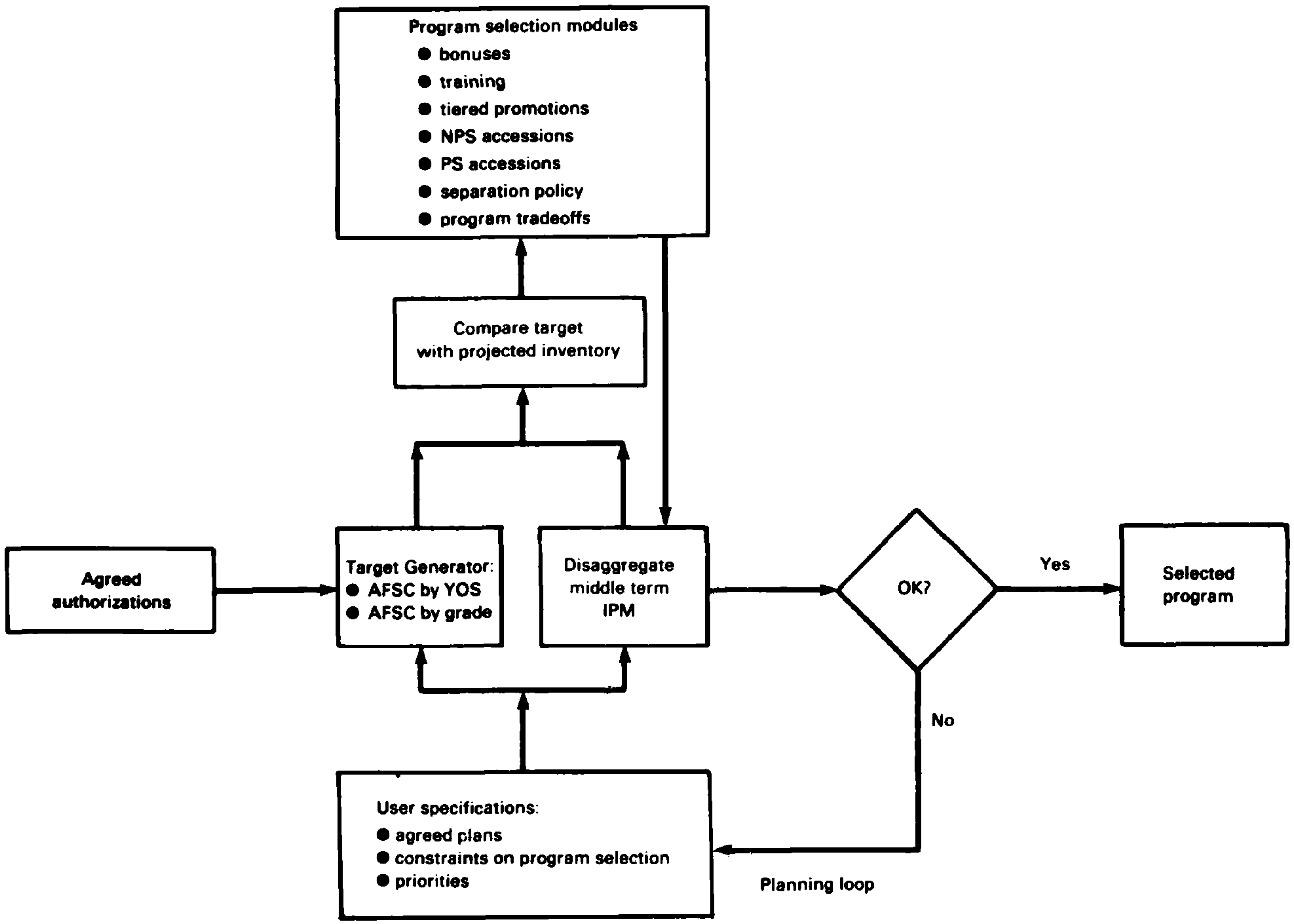
[5] Although the targets from the GRM will imply a YOS distribution for each specialty and grade, these distributions are unlikely to be sufficient for programming purposes. The GRM will assume that the inventory actually matches the target force each year, which will rarely be the true situation. In addition, the GRM may ignore small differences among AFSCs in loss rates (see Sec. 7) that the personnel programmer cannot ignore in producing the inventory.



Note: See Fig. 8.1 for additional input and output

Fig. 8.2 — Modules for selecting occupation-specific programs

Below we review the generation of year of service targets within the TOPCAP system. Then we present the conceptual structure of the ENPRO YOS Target Generator.

In the original TOPCAP design, the desired year of service distribution was determined from the steady-state objective force, with the year of service distribution of feeders and laterals modified to account for reclassification.

Currently, for allocating bonuses, the number of people desired in a particular specialty and year of service group is calculated from (1) the number of authorizations by specialty and grade, and (2) the Air-Force-wide distribution of YOS group for each grade. This formulation ignores the differences between feeders and laterals in the year of service distribution of grades that arise from the timing of reclassifications (see Sec. 7.2).

Although the steady-state assumption is no longer explicitly used to set YOS targets, it is used implicitly. Because the number of persons in adjacent year groups is ignored in setting targets, the targets are only appropriate for a long-running program with stable authorizations. In the short run one could meet the reenlistment targets and have shortages or overages by grade depending on staffing in adjacent year groups.[6]

An equally extreme and unsatisfactory alternative would be to set the year of service targets so that the total number of authorizations in grades that can be affected by a bonus are met in a single target year. This would introduce great variability in the YOS target from year to year. If the targets were met it would introduce management problems as the inventory aged and was promoted.

We believe the appropriate way to set year of service targets for each specialty is to explicitly make a compromise between meeting this year's authorizations and meeting future authorizations. The YOS Target Generator will accept as input a projected time stream of authorizations by specialty and grade, the current inventory, promotion rates, and loss

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[6] SRB managers, of course, do not ignore adjacent year groups. They consider total staffing by grade in setting bonus levels. However, this fact points out the inadequacy of the YOS targets.

rates for the years of service that are not subject to management actions such as bonuses or restricted reenlistment. The user will either specify reclassification flows (e.g., by inputting the files that document current training plans) or allow the model to optimize these flows (see Sec. 8.3.8). The model will determine the time series of losses in each managed year of service that provide the best fit to the entire time stream of authorizations. These losses could be constrained to vary smoothly over time (thus avoiding future management problems) and to be within a range that can be accomplished by management action. In order to ensure that the promotion opportunities implied by the total Air Force grade profile are realized, the total number of persons in each managed YOS could be constrained to equal the number in the official grade profile (and similarly the sum of the AFSC-specific number of career job reservations could be constrained to match the CJRs in the output from the Grade Profile Generator).

8.3.2. Selective Reenlistment Bonuses

Selective reenlistment bonuses (SRBs) are offered to members of selected occupations on the condition that they reenlist or extend for at least three years. The amount of the bonus offer can vary by specialty and by year of service group. Currently there are three YOS groups: Zone A (3-6 years), Zone B (6-10 years), and Zone C (10-14 years).

The aspects of the EFMS that represent the most needed improvements to SRB decisionmaking have already been described: (1) the loss model will predict the number of persons who will choose to reenlist if they are offered a particular bonus amount; (2) the Target Generator will help SRB managers determine how many persons should reenlist.

In addition, we envision that the EFMS will include two decision aids to help personnel programmers develop a bonus plan. The first is a program selection module that solves the two versions of the efficiency problem discussed in Sec. 8.2.2. The second is a diagnostic printout:

1. The <u>Bonus</u> <u>Optimization</u> <u>Model</u> could be used in either of two ways.

(a) It could be used to allocate a fixed SRB budget among specialties and zones so as to minimize the deviation between the inventory and its target. The user could assign weights to specialties so that the needs of mission-critical specialties are met before those of less critical specialties. When this model is used as a program selection module its output could be constrained so that bonus allocations to the same specialty in different time periods do not differ by more than a prespecified number of levels.

(b) By changing the input, the same model could be used to determine the amount of bonuses necessary to bring the inventory in a specialty to within a prespecified percentage deviation from the target or as close as possible to the target.

2. The diagnostic printout would show for a user-specified set of occupations: the reenlistments predicted to occur at each bonus level, the bonus costs, and the reenlistment targets. In addition, it would show the projected inventory and authorizations by grade under each bonus level.

Each of these decision aids will require an estimate of the magnitude of other personnel programs (PS accessions, retraining, etc.) and will list these assumptions in the output.

8.3.3. Training, Retraining, and Reclassification

Air Force enlisted personnel enter occupational specialties in a wide variety of ways, including (1) initial specialty training of NPS accessions, (2) prior service accession,[7] (3) voluntary reclassification at the career point or later, (4) reclassification at the request of Air Force managers to reduce overages and increase the staffing of shortage skills, (5) reclassification into and out of CONUS-imbalanced specialties at rotation, (6) natural career progression from a feeder skill to a lateral skill, and (7) following disqualification in another specialty. Personnel managers have differing degrees of control over these movements. For example, the specialty training of future NPS

[7] Prior service accessions are discussed in Sec. 8.3.6.

training manager cannot control the number of persons who volunteer to enter the career force, but he can suggest specialties to those who volunteer and are in excess of the quota in their specialty. At the other extreme, the number of persons being disqualified is essentially uncontrollable by the Air Staff.

The tasks of the program selection module for training and reclassification are to:

a. estimate uncontrollable flows among specialties;
b. estimate the number of airmen at the career decision point who wish to reenlist in excess of their quota and suggest a desirable and feasible distribution of specialties for them;
c. estimate movement into designated laterals from feeder specialties;
d. suggest the remainder of a reclassification plan for the career force, in terms of the number of airmen by grade leaving and entering each specialty. It would be desirable also to estimate the proportion of this plan that can be fulfilled by volunteers who respond solely to the retraining advisory;
e. calculate the output to be realized from training NPS accessions; and
f. calculate the total requirement for training in each specialty from the sum of the flows in a through e.

This module assumes unlimited availability of NPS accessions and that future plans for PS accessions, bonuses, and promotions are known.

The module will find the set of controllable reclassification flows that bring the inventory into closest possible agreement with the target force in each year of the planning horizon and that are within user-specified constraints. The model is similar to that suggested for the grade restructuring model but differs in several important respects. It will, of course, use the current inventory, not an ideal force, and occupation-specific loss and promotion rates rather than Air-Force-wide averages.

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* See Sec. 8.3.5. for limitations due to the availability of qualified recruits. Other limitations are due to training capacity.

One major output of this module is the Trained Personnel Requirements (TPR) document. This output will be in machine-readable form so that the TPR conference can easily amend the document to incorporate new information or modify the training program to accommodate ATC capabilities and other training requirements. The Air Force has prepared a report that provides a detailed description of the desired capabilities of the programs that will process this automated TPR document.[9] An additional output of the module will be a file of changes to the Retraining Advisory.

8.3.4. Tiered Promotions

The purpose of the tiered promotion system is to increase retention of personnel in particularly critical skills that are chronically short of personnel. Given particular policies concerning training and bonuses, ENPRO will provide a comparison of the projected inventory to projected authorizations and identify the set of skills that meet user-specified criteria for criticality and the magnitude and duration of shortages. Because the loss model will be sensitive to promotion policy, the user will be able to examine the effect of alternative specification of the AFSs in multiple tiers and of various differentials among tiers in promotion rates. We currently expect that this gaming capability will be sufficient to meet the needs of decisionmakers but wish to explore this issue in greater depth before eliminating the possibility of providing a more sophisticated model.

8.3.5. NPS Accessions

We recommend that the initial version of the EFMS assume an unlimited supply of NPS accessions. Under the assumption of unlimited supply, the quantity of NPS accessions can be calculated from the training output needed from NPS accessions (from the training and reclassification module) in a straightforward manner. One finds the timing of the accessions from the duration of the courses and the number of accessions from the needed output adjusted for the expected drop out rates during basic military training and specialty training.

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[9] Major Robert J. Luschenat, "Automated TPR: Functional Description and Design Specifications (General)," AF/MPPPP, March 1982.

The recommendation that analysis of the supply of NPS accessions not be part of the initial operating version of EFMS is based on our understanding of Air Force priorities. The supply of quality recruits has been a minimal problem throughout Air Force history and will not be a problem in the immediate future. To produce a model describing the supply of NPS accessions would require assembling and analyzing a large longitudinal data base covering demographics, economic indicators, and recruiting policy. It seems to us that the Air Force personnel planning and programming community has more pressing problems that need to be addressed in the near term. However, we also believe that the supply of NPS accessions could become an Air Force problem in the not so distant future and consequently recommend that the Air Force consider building such a supply model and incorporating it into the EFMS. The feasibility of such a model has been demonstrated by the NPS Gains module of the Army's ELIM-COMPLIP system.

Even without an NPS accession supply model, it would be possible for the EFMS to translate the TPR into a description of the quality requirements for NPS accessions. For example, it could provide the number of accessions needed at or above various AFQT scores and scores on each area aptitude test. This capability would require data that specify prerequisites (e.g., test scores) and attrition rates during training for each AFSC. Because part of each year's accessions do not complete training until the next fiscal year, data concerning course scheduling would be used to tabulate the NPS accessions requirements on an annual basis. The advantage of this capability is that MPPP analysts could observe how their program decisions affect qualitative NPS accession requirements before making a final decision.

8.3.6. PS Accessions

Only small numbers of PS accessions were recruited by the Air Force until very recently. When prior service accessions with up-to-date skills in needed specialties can be obtained, they are a low cost way of filling deficits in needed personnel compared with bonuses and retraining. The problem is that no one knows how many of those who left the service would like to reenlist or how economic conditions affect this number. If one plans for more PS accessions than one can obtain, one would experience a deficit in skilled personnel for the length of time required to implement an alternative plan.

Building a model of the supply of PS accessions is more difficult than an NPS supply model, because the Air Force has always met the small PS accession quotas that have been set.[10] We view the importance of a PS accession supply model to be very high. However, our desire to ensure that the initial design of the EFMS be feasible leads us to suggest postponing the design of the module to estimate PS accessions. The Air Force is currently sponsoring a survey of ex-servicemen to determine their views concerning rejoining the Air Force. This survey may provide important insights into the supply question. After completing the mathematical specification for the design of the initial version of the EFMS, we would like to tackle this problem.

In the short run, we have no changes to recommend to the system of determining the amount of PS accessions. The set of modules described above will allow the user to observe how the other programs would change in response to changes in the level of PS accessions. In addition, information on the costs associated with training in each specialty will be routinely provided by the system. Because it is more efficient to re-hire personnel who are more costly to train, the information may be useful in forming judgments about PS accessions by specialty.

8.3.7. Separation Policy

We expect that the program selection modules associated with separation policy will be exceptionally simple. In the case of early release programs, the program selection module will calculate the excess between the inventory and desired end strength and allocate this excess to early releases in specialties based on user-specified criteria (e.g., those in shortage specialties or mission critical specialties might not be eligible for early release). By comparing the output from runs with and without early release programs, the manager will be able to determine the additional training costs incurred because of the early

[10] Of course, the NPS accession quotas have also been met. The difference is that the quality of NPS accessions is measurable and has varied over time.

release program. The user will also be able to input a particular early release program and observe its effects on the current and future inventory.

8.3.8. Tradeoffs Among Programs

The modules already discussed will allow the user to consider tradeoffs among all programs in a gaming mode. The user could modify the level of one or more programs and observe the changes that would be necessary in another program, as well as the effects on the inventory and on costs. However, finding a very good solution using this method could be time consuming.

Consequently, we propose to develop a program selection module that simultaneously optimizes over at least two of the personnel programs that are designed to increase the number of experienced personnel.

Given the current state of knowledge, the programs clearly suitable for simultaneous decisionmaking are retraining and bonuses. Whether it is desirable to include tiered promotions in the simultaneous decision set depends in part on the magnitude of the relationship between promotions and losses. Only if the relationship was very large would the possible gain in efficiency of the other two programs justify the increased complexity. In the future, when data on the supply of PS accessions are available, it will be desirable (and probably very easy) to add this category of decisions to the same decision framework.

It would be appropriate to consider the tradeoff between increasing NPS accessions and using programs to increase the number of experienced personnel only if one could calculate productivity as a function of experience levels. Although various methods of calculating relative productivities have been proposed, all of them require considerable additional research, development, and validation before they could be considered for use in an operational system.

We view the tradeoff between retraining and bonuses to be a problem of minimizing costs subject to constraints on the availability of personnel who can be retrained and constraints on the experience level of the persons in each specialty. To be specific, let us consider the special case of retraining at the first-term reenlistment point and bonuses for first-term reenlistment, and assume we are concerned with decisions for only a single fiscal year. For each shortage specialty i, let

R_i = the target for YOS = 5 in specialty i.

C_i = the total cost of retraining a person into specialty i.

B_i = the bonus offered in specialty i.

N_i = the number of persons in YOS = 4 for specialty i.

$P_i(B_i)$ = the fraction of N_i who would be willing to reenlist if offered the bonus amount B_i.

Z = the total number of persons who are in excess of the quota who wish to reenlist and are willing to retrain

X_i = the number of those counted in Z who should enter specialty i

Y_i = the maximum number of persons who will be eligible to enter specialty i because of experience levels.

The simplest formulation of the problem is to minimize:

$$\sum_i B_i(N_i P_i(B_i) + X_i) + C_i X_i$$

subject to:

$$N_i P_i(B_i) + X_i = R_i$$

$$X_i \leq Y_i$$

$$\sum_i X_i = Z.$$

This problem need not always have a feasible solution, so it will be necessary to provide a mechanism to relax the first of the above constraints until a feasible solution can be found.[11] It will be possible to introduce priorities among specialties when the target cannot be reached.

[11] One way of doing this is to turn the problem from a straight mathematical program into a goal program.

In the next phase of this project Rand will extend this model to consider multi-year time horizons and simultaneous decisions for all the relevant YOS groups. We will also explore solution methodologies and recommend a particular feasible algorithm.

9. MODULES FOR OVERSIGHT AND SHORT-TERM PROGRAMMING

In the preceding three sections we discussed modules that carry out two of the three types of functions that the EFMS is being designed to support: policy planning and policy implementation. In this section we discuss modules that will carry out oversight and monitoring.

In the current system (and, indeed, in most decisionmaking environments) practically all the effort is placed on choosing a policy and little or no effort is placed on making sure that the policy works well in practice. But the models used to evaluate alternative policies are only approximations of reality and provide only estimates of what would happen if any particular policy were implemented. Once a policy is implemented, it is important to watch its behavior closely to make sure that whatever was expected from the policy is actually happening. If not, the deviation from plans should be recognized as soon as possible, and changes should be made.

Continual monitoring will also help identify when changes in the operating environment have weakened or invalidated the assumptions on which the policies were based. In such circumstances, a revision of the policies will also be required.

We believe that procedures for monitoring and evaluating personnel plans and programs should be an integral part of the EFMS. The modules to perform these functions are conceptually straightforward, so they require little discussion here. They primarily involve developing output reports and then writing computer programs that will produce these reports. A general flowchart showing the required set of modules is given in Fig. 9.1.

The reports would fall into three categories:

- <u>Monitoring</u>. These reports, produced periodically (e.g., once a month), would show what happened compared with what was expected to happen. Graphical output instead of, or in addition to, tables of numbers would be produced so that trends and relationships would be easy to see and comprehend.

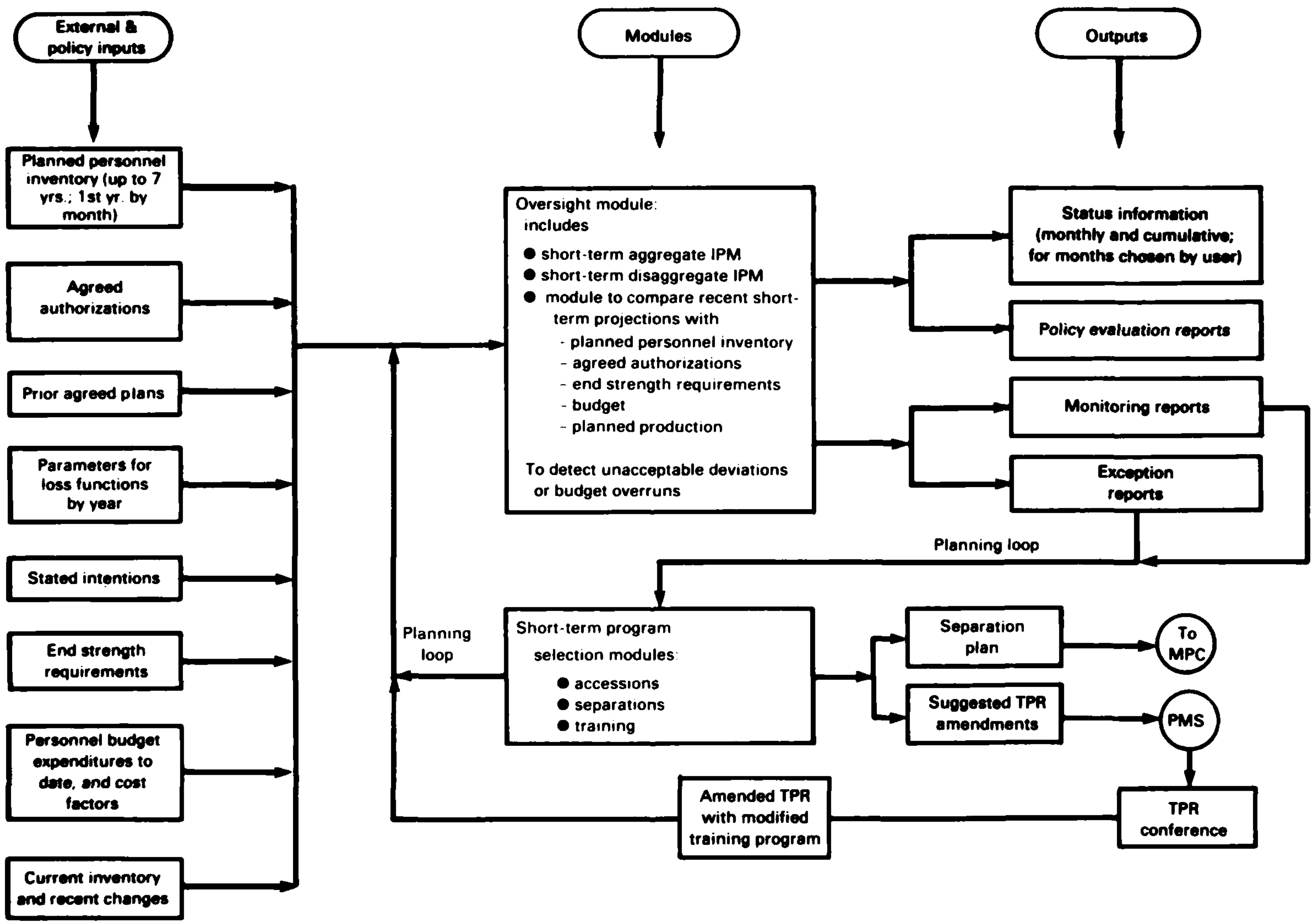

Fig. 9.1 — Modules for oversight and short-term programming

Monitoring reports would be useful for purposes such as end-strength and budget management, monitoring reenlistments, and checking on the outputs from training.

- Exception. An exception report would be produced whenever an unacceptable deviation from plans had occurred. The user would be able to specify what was to be considered "unacceptable." Exception reports would identify potential problem areas in advance. In a "management by exception" reporting environment, the manager does not have to search through piles of computer output to identify exceptional cases. The problems are brought to his attention automatically. Whenever possible, the report would include a description of the source of the deviation (e.g., change in retention, change in planned target, insufficient production). It would also include space for the user to add text (perhaps even on-line) that explains the deviation. Examples of exception reports include an unacceptable projected shortage or overage in some AFSC and a large change in losses in some category.
- Policy Evaluation. A policy evaluation report would examine the effect of a specific policy change compared with its expected effects. When a policy is implemented, a policy evaluation report would be specified and the data for the report would be identified. The system would then keep track of the required data and produce the requested report at a future time specified by the user. Examples of policy evaluation reports would be (1) an examination of the effect of bonuses on reenlistments, and (2) a summary of changes to the TPR by reason and source of change (to provide future year adaptability when setting the TPR). The system will also continuously gather information to facilitate updating of the loss functions. (The updating could be done automatically on a periodic basis if desired.)

The Oversight and Short-Term Programming subsystem will also be capable of producing status reports upon user request or on a periodic (e.g., monthly) basis. The EFMS will include a flexible report generator, which will allow the user to access information in the data base and display it on his or her terminal or in a hard-copy report. The periodic status reports would be pre-defined and would be produced automatically by the system. This type of report is most similar to the reports produced by traditional management information systems. We recommend that such automatically generated status reports be kept to a minimum, and those that are produced contain as few pages as possible.

In many cases, the reports produced by this subsystem require short-term projections (usually to the end of the fiscal year). Thus, two short-term IPMs will be developed: an aggregate IPM for uses such as end strength and budget management; and a disaggregate IPM for projecting overage and shortage situations in AFSCs. The modeling approach to be used in constructing these IPMs was discussed in Sec. 5.2.1. Also to be designed is a module for comparing with actuals and with projections. The targets used in these comparisons will generally be those that were produced by operational runs of other modules in the EFMS. The oversight modules will therefore be able to obtain the targets from the central data base.

If, during the fiscal year, the oversight modules identify unacceptable deviations from targets, several short-term program selection modules will be available to help programmers decide how best to solve the problem. These modules will be very similar to the program selection modules discussed in Sec. 8. However, there will be fewer of them.

The programming options are much more limited in the short than in the middle term. For example, a bonus program cannot be created, approved, and have an effect on loss rates within a few months. There are three programming alternatives to be evaluated for making short-term adjustments in the force: Modify the planned accessions (e.g., temporarily cut off accessions if the force is projected to be larger than the approved end strength at the end of the fiscal year); modify separation programs (e.g., increase "early outs" or approve more waivers of high year of tenure); or modify the planned training program (to increase or decrease the amount of cross-training into or out of specific AFSCs). The EFMS will contain modules that will provide programmers with information that they can use in choosing among these alternatives.

10. GAMING CAPABILITIES

There are two modes in which practically all of the modules in the EFMS will be able to be used: a policy planning (or "gaming") mode and a policy implementation (or "operating") mode. In the gaming mode, the user will be able to explore the implications of varying policy assumptions, assumptions about external conditions, and assumptions about the future characteristics of the force. These explorations will not affect the "official" data in the central data base.[1] Once the user is satisfied with the results of his explorations, he can use the module in the operating mode. In this mode, changes are made in the central data base and reports are produced for official distribution. The output from operating mode runs become official Air Force plans and programs (promotion plans, grade profiles, agreed authorizations, planned personnel inventories, etc.).

The ability to operate modules in a gaming mode is a very important and useful feature of the EFMS. It allows the effects of alternative policies to be evaluated and compared before a policy decision is made. In addition, because the future is always uncertain, gaming allows a policy to be tested under a range of assumptions about future conditions to see how sensitive the policy's outcomes are to the assumptions. (This type of analysis is often called "sensitivity analysis" or "contingency analysis.") Policies that perform well under a wide range of conditions are usually preferable to policies whose success is highly dependent on certain specific future conditions.

In the TOPCAP system, gaming is costly and cumbersome. Most of the programs and their inputs were constructed to be used only in an operating mode. In addition, since all of the system's IPMs use ALPS loss rates, so it is hard to assess the effect that changes in external conditions or Air Force policies would have on the force.

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[1] The system will contain safeguards to prevent users from making accidental or unauthorized changes in the official data and to prevent unauthorized access to the gaming data of other users.

All of the EFMS modules will be usable in a gaming mode. Some of the modules (e.g, the module for estimating the effect of alternative retirement policies) will be used only for gaming.

The EFMS will facilitate gaming in a number of ways:

(1) Most of the modules will be small, fast, and interactive. It will therefore be quick and easy for a user to access a module and run it several times.

(2) The modules will be designed to make it easy to change the assumptions underlying a run. The user will identify the input items he would like to change. The module will accept these changes and prompt for any additional information it needs. If an input item is not to be changed, the system will make a reasonable default assumption about its value.

(3) The user will be able to identify the appropriate input data base to be used. This may be a completely hypothetical set of data--e.g., an authorization structure that represents a major change in the Air Force's missions or weapon systems, or an inventory that represents a change in the career/first-term mix.

(4) The losses estimated by the loss projection models will change as Air Force policies and external conditions are changed.

The types of situations in which gaming can be valuable run the gamut from a change in a single parameter (e.g., high year of tenure for E-7s) to changes in major policies (e.g., implementation of a multi-tier promotion policy). Some selected examples include assessing the effects of:

- <u>a change in authorization structures or end strengths</u>. The EFMS would supply information on the cost of the change (e.g., SRB, training, compensation) and ways to transit the force to match the new requirements.
- <u>a change in the career/first-term mix</u>. The EFMS would supply information on the cost of the change and its implications for accessions, promotions, etc.

- a change in the promotion system-- e.g., a change in eligibility rules or in the formula used to calculate an enlisted member's WAPS score. The output from the GPG will provide great assistance in evaluating such changes.
- a change in loss rates. The EFMS will help programmers decide what they would have to do to compensate for the change.
- an increase in PS accessions.
- a change in the compensation package.
- a change in the civilian economy-- either overall (e.g., decrease in the rate of unemployment) or in a given specialty (e.g., a sharp increase in the civilian wages for air traffic controllers).
- a change in the quality of accessions. The EFMS would supply information on the resulting change in loss behavior.

Additional research will be needed to enable the gaming of some types of policies, because their effects on some measures of performance are not now known. One example of this difficulty relates to the effect of a change in the quality of accessions or in the career/first-term mix. In these cases, the EFMS could supply information on some measures (e.g., changes in loss behavior or manpower costs), but not on the most important measure of performance--the productivity of the force.

11. BUILDING AND IMPLEMENTING THE EFMS

Up until now we have been discussing issues related to the design of the EFMS. This section is devoted to a discussion of how we propose that the system be developed and implemented. We have in mind a process of system development that has been successfully used in many other settings.[1] The two main elements in the proposed approach are (1) the use of a joint project team and (2) staged implementation.

11.1. THE PROJECT TEAM

The development of the EFMS should be a joint effort of Rand and the Air Force. The project team would include members of Rand's research staff and Air Force personnel from MPM, MPX, MPP, MPC, and AFMEA.

Overall control and direction of the project would be provided by a steering committee composed of representatives from the participating organizations. The steering committee would make decisions regarding such strategic items as:

- assignment of priorities
- scheduling of milestones
- assignment of responsibilities
- allocation of resources

It would also keep track of progress on the project and coordinate the project's activities. In addition, the steering committee would provide a focal point for the resolution of issues that arise during system development (such as how best to satisfy certain specific user needs) and for the dissemination of information on the project's progress (e.g., the preparation of briefings for general officers or for OSD).

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[1] See, for example, Ralph H. Sprague, Jr. and Eric D. Carlson, <u>Building Effective Decision Support Systems</u>, Prentice-Hall, Inc., Englewood Cliffs, 1982.

One of the most important reasons for using a joint project team for carrying out the work is that successful implementation of a system as ambitious as the EFMS requires carrying out a large number of tasks using a wide variety of skills. Only a joint team can provide all of the needed skills.

There should be a clear division of responsibility and differentiation of roles between Rand and the Air Force. Tasks would be assigned to one or the other based on comparative advantage. In most cases, responsibility for a task would be assigned to one of the two partners, but the other partner would provide assistance in carrying out the task. In general, Rand would be responsible for developing the conceptual and mathematical specification for the system's modules, and the Air Force would be responsible for transforming these specifications into operational programs and managing the implementation process.

In particular, Rand's major roles and responsibilities would be to:

- develop a conceptual design for the EFMS
- develop the mathematical specification for all models
- refine the mathematical specification of the models as needed during the testing and implementation phases
- provide system programmers with advice on input formats and output reports
- provide advice on desirable hardware capabilities
- help the Air Force to implement the system and set up procedures for operating and maintaining it

The roles and responsibilities of the Air Force would be to:

- identify the specific needs of the various users of the system
- specify the system's hardware
- program the system's modules
- document the system's programs

We suggest that a single group within the Air Force be assigned responsibility for overseeing the development, implementation, and operation of the system. In the following discussion we call this group the System Management Office. During implementation, this office would play the role of a change agent, keeping the users involved throughout the development period and making sure that they understand what is happening and why. The work that this group does before implementation will determine to a large extent how successful the system will be. Studies have shown that people in organizations are more or less resistant to change according to the way that change is introduced.

The System Management Office would consider such organizational and behavioral questions as:

- How will existing procedures be changed?
- Which jobs will be most affected and in what ways?
- How can the people affected be prepared for these changes?
- What sort of training will the affected people need?
- What is the best timetable for implementing the changes?

Once the EFMS has been implemented, the roles and responsibilities of the System Management Office would change considerably. In particular, it would be responsible for:

- setting up and maintaining the system's data base,
- maintaining the system's modules--making changes in the programs in response to the changing needs of the users or changes in Air Force (or DoD) policies and procedures,
- distributing hard-copy reports produced by the system,
- training new users,
- maintaining and updating documentation of the system's modules.

Successful functioning of a joint project team requires continual interactions, good information flows, and close working relationships among the team members. This will be a challenge to the Enlisted Force Management Project, because some of its members are widely separated geographically. However, there are many means at our disposal to reduce the effect of this gap, including:

- trips by team members to other locations (Rand members to Washington, Air Force members to Santa Monica),
- use of common computing facilities and common data bases (Air Force members have already begun to access Rand's computer and data bases from terminals at Bolling Air Force Base),
- telephone calls,
- exchange of memos and documents by courier and pouch (Rand provides overnight mail service between its Santa Monica and Washington locations and provides a daily courier service between the Pentagon and its Washington office),
- instantaneous transmission of important hard-copy material through facsimile machines located at Rand and the Pentagon,
- communication of urgent messages through electronic mail using Rand's text processing system,
- meetings of the steering committee (either face-to-face or by conference calls).

11.2. STAGED IMPLEMENTATION

There are several ways in which the EFMS could be developed. One would be to develop and implement the modules one at a time, leaving consideration of their linkages until all are finished. A second would be to implement the system as a whole at one time after all the modules have been completed. We propose to follow a process that combines the best features of both approaches and avoids their negative features. We call it "staged implementation."

In staged implementation, some modules are developed in parallel with others, and some are developed sequentially, in priority order. Use of a module can begin whenever it has reached the point that a user feels comfortable trying it. In addition to the implementation of modules one at a time, development of each module is an iterative process that includes some or all of the following:

- conceptual design,
- mathematical specification (which includes mathematical modeling, estimation of the parameters of the model, and validating the model using historical and hypothetical data,
- programming a stand-alone prototype of the module
- testing and using the prototype for some or all of its intended functions,
- evaluating the test,
- revising and improving the mathematical specification (which includes adding features to the model),
- reprogramming the module for inclusion in the system,
- preparing and maintaining whatever historical data base is needed for updating and reestimating the model,
- integrating the module into the system.

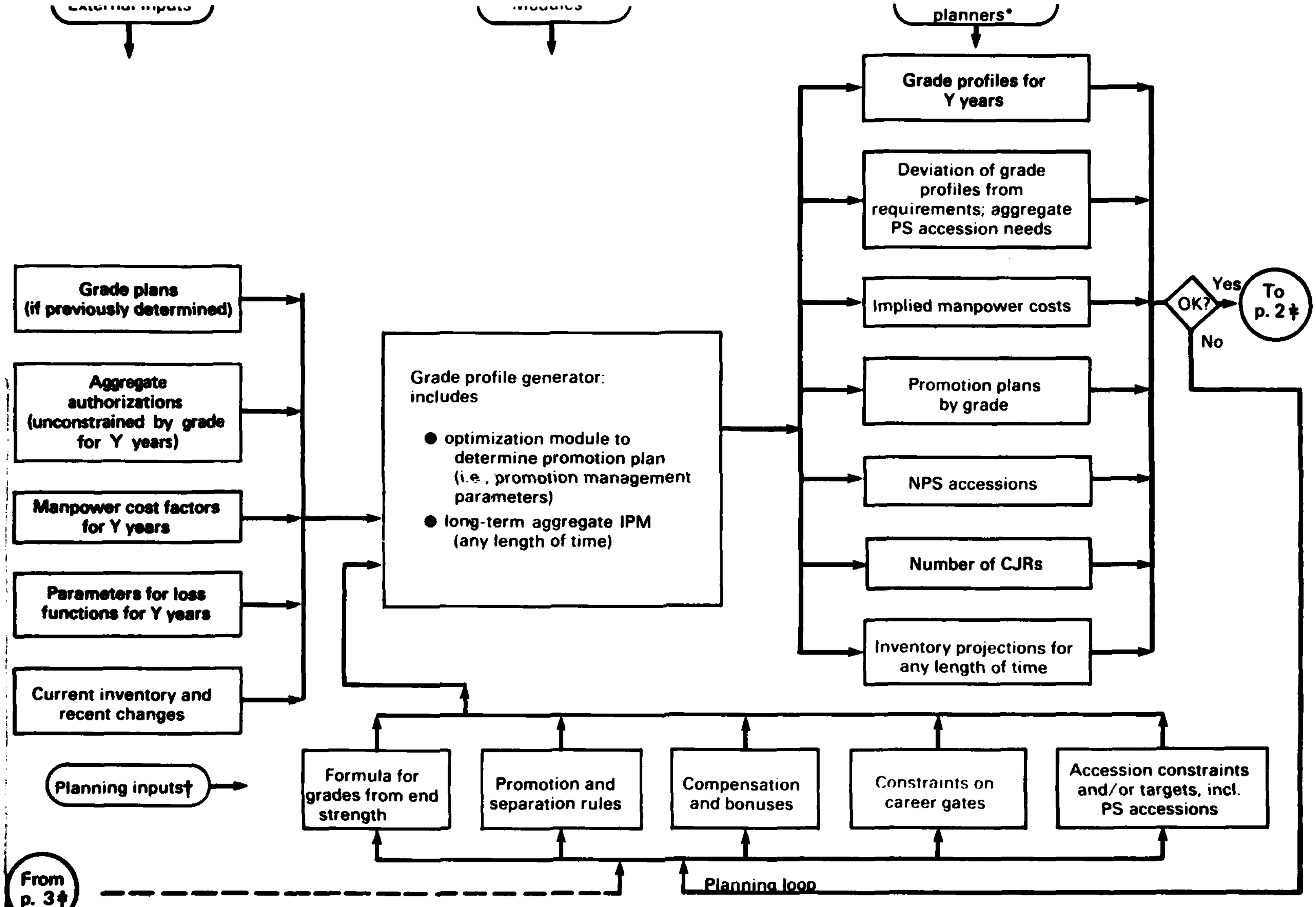
All of these steps would not necessarily be carried out for each module, and the development of each module would not necessarily involve carrying out the steps sequentially. There would be a lot of iteration and feedback among the steps. For example, testing of the prototype might reveal problems that would return development of the module to any of the previous three steps (even rethinking the conceptual design).

The prototypes are likely to include some, but not all, of the features of the final versions of the modules. In most cases, the inputs, outputs, and user interactions of the prototypes would be very different from those planned for the EFMS. However, there are several good reasons for using them in these early versions:

- Useful results for personnel planning and programming can be obtained early in the system development process (e.g., early support for bonus management or grade profile generation).
- Problems with the modules can be identified and corrected early in the process.
- Users can gradually become familiar with the concepts, procedures, and modules of the EFMS.
- The System Management Office can gradually build up its organization and procedures.

Appendix

RAND EFMS FLOWCHART



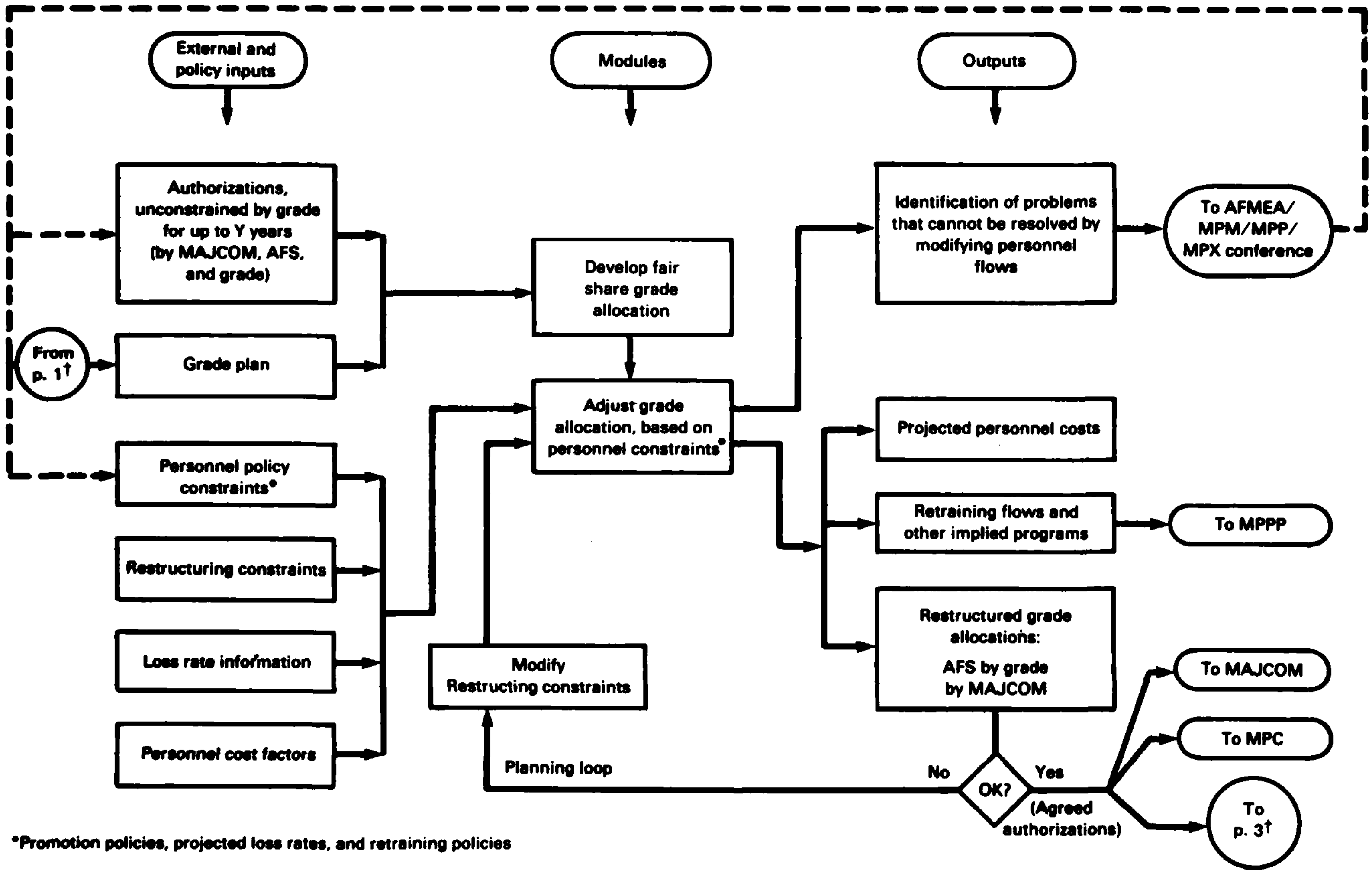
*Analysts will be able to see various versions of the output and comparisons among the versions (e.g., meet Congressional constraints exactly vs. stay under constraints).

†Some of these can be specified arbitrarily by the analyst or may be determined by policy or previous decision cycle (depending on the purpose of running the module, the time frame under consideration, etc.)

‡Page numbers refer to pages of the Rand EFMS Flowchart.

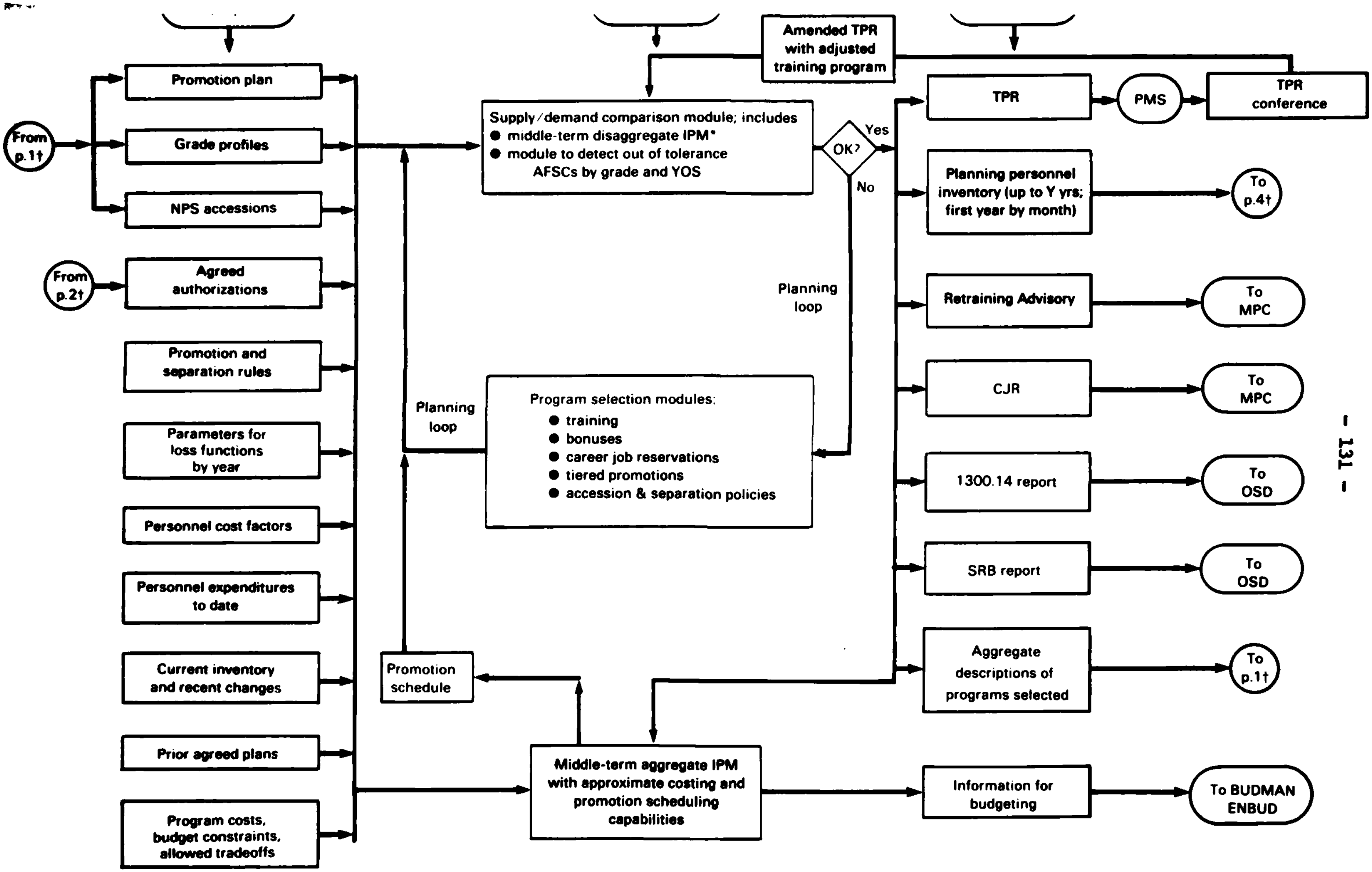
Rand EFMS Flowchart
Page 2

GRADE RESTRUCTURING MODULES



*Promotion policies, projected loss rates, and retraining policies

†Page numbers refer to pages of the Rand EFMS Flowchart

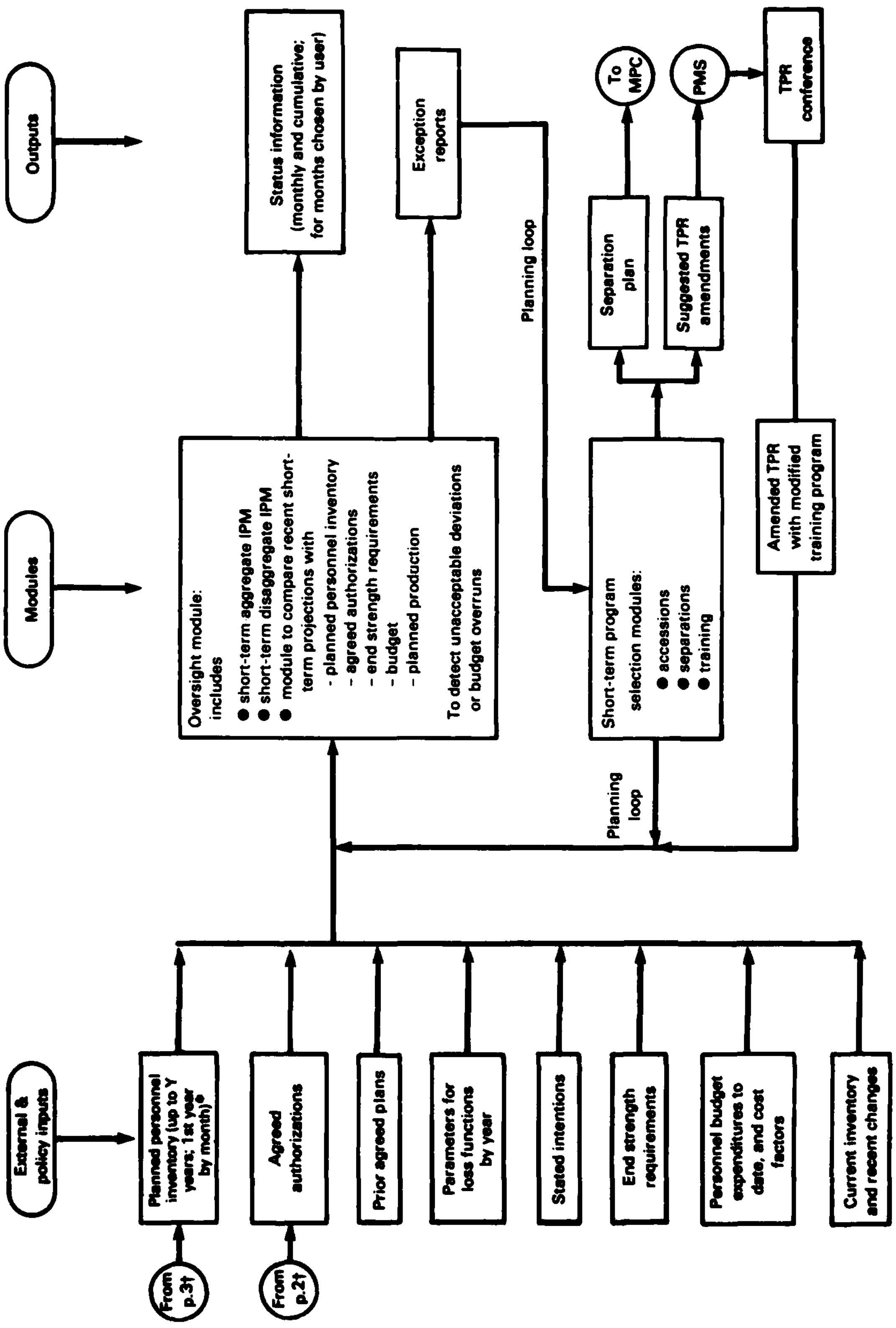


*Optionally, this can be forced to be compatible with aggregate IPMs (p. 1 and this page)

†Page numbers refer to pages of the Rand EFMS Flowchart

Rand EFMS FLowchart
Page 4

MODULES FOR OVERSIGHT AND SHORT-TERM PROGRAMMING



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